PRO FOOTBALL HALL OF FAME YOUTH AND EDUCATION

SCIENCE

ACTIVITY GUIDE 2022-2023

PRO FOOTBALL HALL OF FAME

ACTIVITY GUIDE 2022-2023
SCIENCE
TABLE OF CONTENTS

Animal Sort

Goals/Objectives:

Students will:

- Identify characteristics of organisms
- Sort organisms according to different characteristics

Next Generation Standards: LS1 - From Molecules to Organisms: Structures and Processes; LS2 - Ecosystems: Interactions, Energy, and Dynamics

Methods/Procedures:

- Discuss how each football team has a mascot, such as the Detroit Lions or the Philadelphia Eagles (refer to page 6 in the Football Facts & Figures section for complete list of team names). Have the students brainstorm different mascots for teams.
- Distribute animal pictures. Teacher and students will search for pictures of these animals for a visual aid. The teacher will name a characteristic an animal could have and the students will sort all of their animal pictures into categories according to that characteristic, for example: animals with wings, animals that fly, animals that have sharp teeth for eating prey, animals that live in water, animals that live in forests, etc.
- Animals can also be sorted by carnivore/herbivore or nocturnal/diurnal.

Materials:

- Scissors
- Handout of animal pictures
- List of Team Names and Mascots

Assessment:

- Ability to sort animals according to characteristics determined by the teacher
  * Baltimore Ravens
  * Cincinnati Bengals
  * Denver Broncos
  * Indianapolis Colts
  * Jacksonville Jaguars
  * Miami Dolphins
  * Arizona Cardinals
  * Atlanta Falcons
  * Los Angeles Rams
  * Seattle Seahawks
  * Carolina Panthers
  * Chicago Bears
  * Detroit Lions
  * Philadelphia Eagles

EXTENSION ACTIVITY:

- The children can discuss what animal characteristics best fit an NFL team.
- The children can create a new NFL team and create a mascot based upon those characteristics.

Collisions on the Gridiron

Goals/Objectives:

Students will:

- Explore the Pro Football Hall of Fame through the website and/or tours.
- Find real life examples of the motions and forces as they apply to the NFL.
  * Identify balanced and unbalanced forces.
  * Identify examples of Newton's third law of motion.
  * Find examples showing how force and mass are related to momentum.

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- Students are to find player information on weight and 40-yard dash time to use for calculations.
- Students will start with the Pro Football Hall of Fame website to find resources.
- Students will use the NFL site to find additional information, pictures, graphics or any other materials and information needed to complete the goals and objectives of the lesson.
- Visits to the Pro Football Hall of Fame may be used to gather information.
- Using the attached formulas, students will calculate speed, energy and force created from football collisions.

Materials:

- Students may use a variety of materials to complete the lesson.
- Worksheet and formulas on the following pages.

Assessment:

- Completion and scoring of worksheet material.
- Student/Teacher created scoring rubric.
- Written summation.

Collisions on the Gridiron

So how much force is generated in a tackle? Using a mathematical formula, we can discover how much energy is expended in an open field tackle. Late in the third quarter of a game there is a 4th and goal situation. Your favorite running back is up against your favorite linebacker. In the open field both players collide. Whose force will prevail?

Your task is to come up with the player information on weight and to calculate the players' speed using 40-yard dash times. Then as fan, you may want to prepare for a small earthquake in the stadium. Just how much energy results from this collision?

Running Back

Weight lbs. _____ Speed in mph _____

Linebacker

Weight lbs. _____ Speed in mph _____

In our calculations, we'll assume that the players become entangled and "stick" to each other during the collision. This is called an inelastic collision. Even though the players may not come to a complete stop (depending on their weights and speeds), we can still calculate the amount of energy that will be dissipated in the collision. We do this by calculating the energy of each player before the collision, and subtract the energy of the combined players after the collision. The kinetic energy of each player before the collision can be calculated with the equation:

Energy = $(^1/_2)$mass x velocity^2

The energy after is:

Energy = $(^1/_2)$total-mass x final-velocity^2

To find the final velocity, you use the fact that the initial momentum (mass x velocity) of both players must equal the final momentum of the players:

(mass player 1 x velocity player 1) + (mass player 2 x velocity player 2) = combined mass x final velocity

Notice that in the above equation we know all the variables except for the final velocity. We solve for this and get:

$$\text{final velocity} = \frac{[(\text{mass player 1} \times \text{velocity player 1}) + (\text{mass player 2} \times \text{velocity player 2})]}{\text{combined mass}}$$

The energy comes out in a metric unit called a "joule". A joule is not a lot of energy. It's about the amount of energy you'd use to lift an apple to the height of your waist (1 meter).

To find the stopping force, we assumed the collision between the players took about 1/4 of a second. Knowing this, we can look at the change in momentum of either player and use the formula:

$$\text{force} = \frac{\text{change-in-momentum}}{\text{time of impact}}$$

According to Newton's third law -- for every action there is an equal and opposite reaction -- each player must experience the same force.

Football Games In Dangerous Weather

Goals/Objectives:

Students will:

- Identify dangerous weather that may occur during football games
- Discuss consequences of being struck by lightning

Next Generation Standards: ESS2 - Earth's Systems

Methods/Procedures:

- Students should be familiar with reasons why some sports activities may be cancelled. Discuss with the students different types of weather and how it may have adverse effects on a football game.
  * Rain: Difficult to see, muddy ground, players may slip easily
  * Snow: May be difficult to see, slippery ground
  * Ice: Players may fall and suffer injuries
  * Fog: Players can't see in front of them
  * Severe heat: Players can get dehydrated
  * Severe cold: Players may get frostbite
  * Lightning: Players could get struck by lightning.
- Share with the students different stories of football players who were hit by lightning.
  1. In the fall of 1970, 30 American football players, coaches, and spectators were struck by lightning on or near a football field.
  2. During a light rain shower one college senior was flattened by a bolt of lightning. His heart stopped and then restarted. Three nearby teammates were knocked unconscious.
- Discuss with students some possible side effects of being struck by lightning. It could result in death, concussions, neurological complications, burns, cataracts in eyes, or unconscious state.
- Discuss with students possible reasons for so many players being struck by lightning. Players have a lot of equipment with metal: metal facemasks, belt buckles, and athletic supporters. Some football players have long hair, which could cause static electricity.
- Have students make lightning. Do this on a cool, dry day. Here are the directions:
  1. Choose a partner
  2. Make the room as dark as possible.
  3. Rub your feet back and forth on the carpet to create heat.
  4. Touch your partner with one finger.
- Have students share what they saw and felt. Discuss why it happened. How was energy transferred? Students can do the experiment with one student rubbing his/her feet on the carpet and then with both students rubbing their feet on the carpet.
- Here is an optional extension: Students can even make lightning in their mouth. It needs to be done on a cold, dry day. Here are the directions: 1) Put two wintergreen Life Savers in their mouth, with the room as dark as possible. 2) Chew the Life Savers with their mouths wide open. 3) Watch in a mirror to see what happens.

Materials:

- Carpeted flooring
- 2 Wintergreen Life Savers (optional)
- Mirror (optional)

Assessment:

- Discussion about how weather affects football games.

Getting Into Shape... The Shape of a Football

Goals/Objectives:

Students will:

- Review the process of scientific inquiry
- Examine the question posed and formulate a hypothesis, test it by collecting data, and compile the results
- Record the data in a chart and find the average
- Learn how to create a bar graph using the above data
- Develop a theory based on the process of the scientific inquiry

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- The teacher creates this scenario: You are babysitting for a small child and the electricity has gone out…no television, no video games to play, and no computer can be used. So you decide to take out his football and toss it around. The small child always asks the same question…"Why?" Why did the electricity go out? Why is the television not working? Why is the football the shape it is? Now you need to find the answer to that question.
- The child has posed the question for you to try and help him understand. Why is the shape of a football the shape it is? First, identify the shape as an elliptical shape in 2-D. Draw it. Then explain that the 3-D shape is called a prolate spheroid.
- Use the one variable of shape and test it for distance. Consider the shape of a round rubber ball and a square plastic Tupperware or food storage container. Be sure they are all about the same size.
- Each student in the class will be asked to pretend they are the small child and to make a prediction or form a hypothesis. Example: The round ball will go further when thrown. Divide the class into groups so that they can test their hypothesis.
- Explain the procedures for this (ie., the group will need to do 3 tries for each test to be sure the data is accurate; the kick or throw should be done by the same student so that strength is not a variable).
    * The idea of kicking to compare distance may be withheld depending on your class and their limitations.
- Have students create a chart comparing the prolate spheroid's distance when thrown to the round ball and the square's distance when thrown. Collect the data for three tries each. Then record the data into your chart. Find the average for the three tries by adding up the number and dividing by three.
- Compare accuracy of a throw by using a target with rings around the bull's eye. Set it up so the throws are equal distance away. Give the bull's eye 5 points, first ring around it 4 points, next ring 3 points, and keep going with the rings getting bigger and worth less points, until you reach 0 points.
- Record the data in a chart comparing the three tries for each, and then find the average for each shape by dividing the numbers by three.
- Create a bar graph based on the findings. There will be two separate bar graphs, one for distance and one for accuracy.

Getting Into Shape... The Shape of a Football

- This experiment should be conducted outside or in a space in the gym where there is plenty of room for these activities.
- Each group will then present its findings to the class by explaining the graphs.
- After results are shared, it might interest the students to view the following website: http://www.profootballhof.com/photos/gallery/the-evolution-of-the-football/

Materials:

- Teacher created scenario
- Traditional footballs
- Round rubber balls
- Square plastic storage containers
- A target with bull's eye and rings around it
- Chart in "research notes"
- Access to the internet

Assessment:

- Completed chart
- Completed bar graph using results of experiment.
- Students will present their findings to the class as to the best shape for distance and accuracy based on their data.

Getting Into Shape... The Shape of a Football

Name: Class:	**Prolate Spheriod (Football)**	**Round Rubber Ball**	**Square Container**
Distance Ball Can Be Thrown	1. _____ 2. _____ 3. _____ Average: _____	1. _____ 2. _____ 3. _____ Average: _____	1. _____ 2. _____ 3. _____ Average: _____
Accuracy of Throw Based on Target (Simulates pass from quarterback to reciever)	1. _____ 2. _____ 3. _____ Average: _____	1. _____ 2. _____ 3. _____ Average: _____	1. _____ 2. _____ 3. _____ Average: _____
Distance Ball Can be Kicked (option-al)	1. _____ 2. _____ 3. _____ Average: _____	1. _____ 2. _____ 3. _____ Average: _____	1. _____ 2. _____ 3. _____ Average: _____

The Purpose of Eye Black

Goals/Objectives:

Students will:

- Introduce or review the terms reflect, absorb, glare and albedo
- Use knowledge of reflection and absorption of light on the ability to see
- Determine the importance of a football player's eye black.

Next Generation Standards: ESS2 - Earth's Systems

Methods/Procedures:

- Ask students to create a list of things that glare (shining brightly and blindingly) and cause one to squint and wear a visor/sunglasses. (i.e. sunlight, snow, water, stadium lights) What do those things have in common?
- Ask students to create another list of things that they can use in the above situations to help them to see. (i.e sunglasses, visors, caps, eye black). What do those items have in common (i.e. dark color, cover the sun…)?
- Review the terms reflection and absorption as the returning of light and as soaking up light
- Ask the children to look at their lists and determine what color would be best to absorb light to improve vision.
- NASA defines albedo as the ration of the light reflected by a body to the light received by it. The value of albedo can range from 0 pitch black absorption to 1 which is a perfect reflection of light.
- Black has the lowest albedo score. How will that make the best eye black?
- Ask the children to complete the sentence. "Eye black is important to football players because_____."

Materials:

- Samples of eye blacks, visors, sunglasses
- Glare charts
- Pencils
- Extended Response page

Assessment:

- Extended response question. A correct response will include vocabulary and include the lesson's discovery that black has an albedo range of 0, reflects light, and allows the football player to see without glare.

The Purpose of Eye Black

Name:_____

List 1 – Things with a Glare and Cause One to Squint

1. _____
2. _____
3. _____
4. _____
5. _____

List 2 – Things to Wear to Prevent Glare and Squinting

1. _____
2. _____
3. _____
4. _____
5. _____

The Purpose of Eye Black

Name:_____
Date:_____

Respond to the following question using today's vocabulary and including your discovery.

How does eye black help a football player?_____

Momentum and Football

Goals/Objectives:

Students will:

- Define momentum
- Calculate momentum
- Analyze factors affecting momentum
- Define Newton's third law of motion
- Explain the law of conservation of momentum
- Apply Newton's third law of motion and the law of conservation of momentum to a football scenario

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- Using available resources, have students define momentum (inertia in motion) and determine how to calculate momentum (multiply the mass of an object by its velocity; momentum = mass x velocity or momentum = mv).
- Explain to students that a moving object can have a large momentum if it has a large mass, a high speed, or both. Give the following example to illustrate: a moving truck has more momentum than a car moving at the same speed because the truck has more mass. However, a fast car can have more momentum than a slow truck.
- Using available resources, have students define Newton's third law of motion. (When one object exerts a force on a second object, the second object exerts a force on the first that is equal in size and opposite in direction. In other words, "to every action force there is an equal and opposite reaction force.")
- Using available resources, have students define the law of conservation of momentum (the total amount of momentum of a group of objects does not change unless outside forces act on the objects).
- Brainstorm factors that would have an affect on the success of a running play in a football game (skills of the ball carrier, blockers, and defending players, size of the players, speed at which players are running, weather, condition of the field, etc.). Have students complete the Momentum and Football worksheet provided on the following page in which the only variables are the masses of the offensive and defensive players and their velocities. Share responses.

Materials:

- Physics resources
- Worksheet: Momentum and Football

Assessment:

- Correct responses to questions on worksheet

Momentum and Football

Name:_____

Given the four football scenarios below, assume that in each case the ball carrier meets the opposing defensive player head-on at the goal line. There, the defender wraps his arms around the ball carrier. Considering the only variables of masses of the offensive and defensive players and their velocities, respond to the questions.

Scenario #1	Mass	Velocity
Offensive Player	93 kg	5.2 m/s
Defensive Player	136 kg	2.2 m/s

Scenario #2	Mass	Velocity
Offensive Player	85 kg	8.8 m/s
Defensive Player	105 kg	6.9 m/s

Scenario #3	Mass	Velocity
Offensive Player	89 kg	6.5 m/s
Defensive Player	113 kg	5.7 m/s

Scenario #4	Mass	Velocity
Offensive Player	108 kg	5.9 m/s
Defensive Player	95 kg	8.3 m/s

Momentum and Football

Directions: Answer the following questions using the information from the chart you filled in. Be sure to show all of your work.

1. Which ball carriers are most likely to score touchdowns? Explain.

2. Which defensive player has the greatest momentum? Considering all of the defensive players, what factor seems to be most significant in giving this player the greatest momentum?

3. In Scenario #3, whose momentum changes the most? Explain.

4. In Scenario #4, how is the total momentum of the players affected by their collision? Explain

Home Sweet Home: Get Me to My Biome

Goals/Objectives:

Students will:

- Look at a map and identify the different ecosystems in the United States and the world
- Identify the mascots of the NFL teams and the ecosystem where they belong
- Determine what makes up an ecosystem and what is unique to each one

Next Generation Standards: LS1 - From Molecules to Organisms: Structures and Processes; LS2 - Ecosystems: Interactions, Energy, and Dynamics

Methods/Procedures:

- Conduct a discussion of the basic needs of all living things. Determine what all living things need (food, water, shelter, and oxygen). Continue by discussing the definition of a habitat (a place where a living thing gets everything it needs).
- Look at the different biomes (land) and ecosystems and determine what the non-living factors are; the soil, water, and climate in the environment, and the living factors; the plants and animals that live in the environment.
- Divide the class into groups and have each group research a different ecosystem. Use the following: Forests (Deciduous, Coniferous, Tropical Rainforest), Grasslands, Deserts, Tundra, Marine, and Freshwater. Find out what characteristics are common in each ecosystem, such as the climate, (temperatures and rainfall) soil, plants, animals, and how the animals may need to adapt to their environments. Students can use a chart to keep their research notes.

Materials:

- Chart for research notes
- Internet access
- Research notes
- A large chart or bulletin board to compile information about the ecosystems and to show where each mascot belongs

Assessment:

- Complete and accurate chart of information regarding the assigned biome
- Be able to locate the biome on the map
- Be able to accurately place the mascot in the correct biome or ecosystem

Home Sweet Home: Get Me to My Biome

Temperature (Climate- over a long period of time)	
Rainfall (Climate- over a long period of time)	
Soil and Water Information	
Plants	
Animals	

Have the students examine the NFL mascots and determine which ones would belong in which ecosystem. To find where the biomes are located, go to this website:
http://www.physicalgeography.net/fundamentals/9k.html
Know that the coniferous forest and the temperate boreal forest are the same.

NFL Mascots

Baltimore Ravens

Cincinnati Bengals

Denver Broncos

Indianapolis Colts

Jacksonville Jaguars

Miami Dolphins

Arizona Cardinals

Atlanta Falcons

Carolina Panthers

Chicago Bears

Detroit Lions

Philadelphia Eagles

Los Angeles Rams

Seattle Seahawks

Muscles and Football

Goals/Objectives:

Students will:

- Students will identify the muscles needed for a variety of activities

Next Generation Standards: LS1 - From Molecules to Organisms: Structures and Processes

Methods/Procedures:

- Students will take turns throwing and catching a football noting what muscles are being used and how they are used. (arm, hands, chest, upper back, legs, feet..) The notes will be used for the next step.
- Students will work in pairs or teams. Using bulletin board or butcher paper the students will trace each person's body on the paper. This will be used to make the students' "Muscle Maps."
- Students will use different colored markers to label the areas where the muscles are used for throwing and catching. One color will be used to mark the muscles for throwing and one color can be used to show the muscles the muscles used for catching.
- Once their paper bodies are labeled, students can hang them on the wall in the room or hallway.
- Allow the students to look at each other's muscle map.
- Return to partners or teams.
- Create a Venn Diagram based upon the creation and observations of the muscle maps.
- Use the muscle maps and Venn Diagram for discussion.
- Discussion Questions:
  * Was there anything on your muscle maps that surprised you? If yes, please explain.
  * Are there muscles that are used to both throw and catch? If so, do you think they are used in the same way? Please explain.

Materials:

- Colored Markers
- Bulletin Board / Butcher Paper
- Venn Diagram
- Pencil / paper

Assessment:

- Completed notes, maps and diagrams
- Observations of discussions

Newton's First Law of Motion in Football: Motion Stories

Goals/Objectives:

Students will:

- Be able to identify potential energy and kinetic energy in a "graph of motion"
- Review Newton's First Law of Motion and apply it in football
- Be able to read a graph of an object in motion and create a story about it, relating it to football

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- Hold a football and then throw it to a student, emphasizing the point of release. Have students discuss the difference between kinetic energy and potential energy and relate it to the action performed. (The kinetic energy is the energy which causes movement. Potential energy is the energy an object has due to its position…waiting to be thrown, for instance.)
- Ask students what kind of energy a football has on its tee waiting to be kicked (potential)? What about while in the air right after the kick-off (kinetic)?
- Elicit from the students Newton's First Law of Motion and emphasize the following: Newton's first Law of Motion says that an object in motion will stay in motion, and an object at rest will stay at rest unless it is acted upon by an unbalanced force.
- Try to have students put this in their own words to be sure they understand it. An object that is not moving remains at rest until something pushes or pulls it (applies force). An object that is moving remains moving until something pushes or pulls it.
- Have students apply this law by looking at a graph of the movement of a football. The line on the graph represents the football's flight. Have the students guess what is happening to the football and if they can determine when there is a change in motion due to a force. There should be a response for every point on the graph. An example is given for you to use with them for the first graph.
- Have them write what the force may be to cause the change in motion, creating a football story from the graph. The stories will vary. To differentiate and extend the activity, students should designate in the story where potential energy is used and where kinetic energy is used. They could also identify where gravitational force is likely. They can identify this in their story by the letters K, P, and G.
- Have students try several motion stories and relate it to football.

Materials:

- Football for demonstrating the idea of potential and kinetic energy
- Graphs with different lines to show motion
- Paper for writing the story

Assessment:

- Students will write their own story identifying the force that changes the motion based on the graph given.
- Then they will create their own graph showing motion and tell the story of what is happening as it relates to football or they can have another student create the scenario to go with their line graph. For extended learning, students can identify what type of energy is being used at each point in the story.

Newton's First Law of Motion in Football: Motion Stories

Distance

A quarterback got ready to throw the football to his receiver. The QB is 6 ft.1 inch tall, so he begins with the football at 5 feet. He threw the ball but before it got to the receiver, a defending player tipped the ball away. Another defending player caught it and was tackled to the ground. [The energy of the football before the quarterback's release is potential energy. The ball being tipped by the opposing player is kinetic energy because he made the ball change its motion. As the player was tackled, gravitational force brings him down with the ball.] These are examples of an object moving in a direction until there is a force pushing or pulling on it (add the possibility of a big wind gust or a huge bird flying into the ball for humor).

Distance

What happened to this football..... or player?

_____

_____

_____

_____

_____

Physics and Football

Goals/Objectives:

Students will:

- Determine what factors influence the distance of a football that has been kicked.

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- Divide the class into two groups. Group A will kick the football and Group B will observe and measure. Groups may then switch roles and repeat the activity.
- Mark the kicking position and mark the area if you are performing the activity anywhere but the football field.
- Create a chart or table on which to record observations. Also record the condition of the field and description of surface. If individual student body type is recorded, students can determine the role, if any, this plays in the distance the ball travels.
- Instruct Group A members to each kick the football six times, three times standing and three times running.
- Instruct Group B members to record the landing point each time. Group B can estimate angle of the kick as well.
- Have students analyze data.
- This would lend itself to a follow-up activity on another day with different weather and surface conditions.
- Have students draw conclusions and present the data and conclusions to the class.

Materials:

- School football field
- Paper
- Pencils or pens
- Footballs
- Tape measures

Assessment:

- Teacher-created rubric scoring data collected as well as analysis and conclusions.

Potential or Kinetic Energy?

Goals/Objectives:

Students will:

- Identify the difference between potential and kinetic energy

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- Introduce to the students the terms potential and kinetic energy with the following demonstration. Hold a football in your hand. Ask the students if they think the ball has any energy. Explain that as you pick the ball up, it gains potential energy. Potential energy is stored energy.
- Let go of the football. What does the ball do? As the ball falls, the potential energy turns into motion. This energy of motion is kinetic energy. When the ball bounces back up, is it potential or kinetic energy? (Potential energy) The ball doesn't have any more energy when it stops bouncing.
- Make sure students realize that energy is always changing.
- Brainstorm some examples of potential and kinetic energy. Here are some examples:

  Potential Energy
  Parked car
  Rubber band between fingers
  Quarterback holding a football

  Kinetic Energy
  Moving car
  Rubber band as it snaps back
  Football as it is thrown

- Show a video clip of a football game. Have students identify examples of potential and kinetic energy.

Materials:

- Football
- Video clip of a football game, choose one from link below.
  www.nfl.com/videos/nfl-game-highlights

Assessment:

- Identification of examples of both types of energy

The Flight of the Ball

Goals/Objectives:

Students will:

- Explore the Pro Football Hall of Fame by visiting the website.
- Find examples of the flight of the ball as they apply to the NFL.
- Identify trajectory.
- Find examples of a projectile.
- Find evidence of friction and how it affects the flight of the ball.
- Find evidence to support the presence of gravity.

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- Students are to create posters, displays, power points or other forms of multimedia that support the goals and objectives of the lesson.
- Students will start with the Pro Football Hall of Fame website to find resources.
- Students will use the NFL site to find additional information, pictures, graphics or any other materials and information needed to complete the goals and objectives of the lesson.
- Visits to the Pro Football Hall of Fame may be used to gather information.

Materials:

- Access to computer
- Access to the Internet
- Science of the NFL Football: Projectile Motion and Parabolas
  * youtube.com/watch?v=HB4ws7RoA3M
- Paper
- Pencils or pens
- How the Physics of Football Works

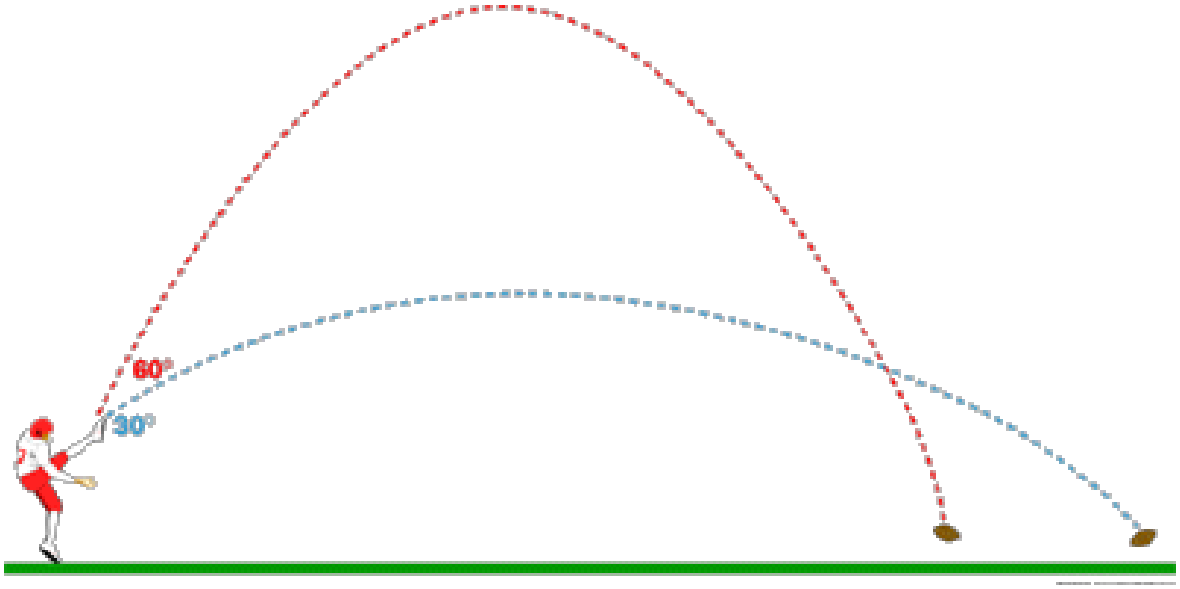
Assessment:

- Student/Teacher created scoring rubric for the presentation.

How the Physics of Football Works

Craig Freudenrich, Ph.D.

Throwing or Punting the Football



The angle of a kick helps determine how far it will travel.

Throwing the Football

When the football travels through the air, it always follows a curved, or parabolic, path because the movement of the ball in the vertical direction is influenced by the force of gravity. As the ball travels up, gravity slows it down until it stops briefly at its peak height; the ball then comes down, and gravity accelerates it until it hits the ground. This is the path of any object that is launched or thrown (football, arrow, ballistic missile) and is called projectile motion. To learn about projectile motion as it applies to football, let's examine a punt (Figure 1). When a punter kicks a football, he can control three factors:

- The velocity or speed at which the ball leaves his foot
- The angle of the kick
- The rotation of the football

The rotation of the ball -- spiral or end-over-end -- will influence how the ball slows down in flight, because the ball is affected by air drag. A spiraling kick will have less air drag, will not slow down as much and will be able to stay in the air longer and go farther than an end-over-end kick. The velocity of the ball and the angle of the kick are the major factors that determine:

- How long the ball will remain in the air (hang-time)
- How high the ball will go
- How far the ball will go

When the ball leaves the punter's foot, it is moving with a given velocity (speed plus angle of direction) depending upon the force with which he kicks the ball. The ball moves in two directions, horizontally and vertically. Because the ball was launched at an angle, the velocity is divided into two pieces: a horizontal component and a vertical component. How fast the ball goes in the horizontal direction and how fast the ball goes in the vertical direction depend upon the angle of the kick. If the ball is kicked at a steep angle,

then it will have more velocity in the vertical direction than in the horizontal direction -- the ball will go high, have a long hang-time, but travel a short distance. But if the ball is kicked at a shallow angle, it will have more velocity in the horizontal direction than in the vertical direction -- the ball will not go very high, will have a short hang-time, but will travel a far distance. The punter must decide on the best angle in view of his field position. These same factors influence a pass or field goal. However, a field goal kicker has a more difficult job because the ball often reaches its peak height before it reaches the uprights.

Source: http://entertainment.howstuffworks.com/physics-of-football1.htm

Weather Observations: Should the Game Be Played?

Goals/Objectives:

Students will:

- Describe the weather predicted at game time by measurable quantities, including temperature, wind direction, wind speed, precipitation and barometric pressure.
- Discuss the likelihood of a game being delayed or suspended when given real or hypothetical weather conditions.

Next Generation Standards: ESS2 - Earth's Systems

Methods/Procedures:

- Severe weather conditions can threaten the safety of both football players and spectators during games and practice sessions. Here are a few guidelines that are generally used:
  * Weather conditions that can cause games to be delayed or cancelled include lightning, severe storms, tornadoes, high heat/humidity and a low wind-chill index.
  * Athletic programs should use a weather radio equipped with the emergency alert system provided by the nearest National Weather Service broadcast station.
  * If lightning exists, find the closest safe shelter. Monitor how near the lightning is striking and the number of seconds between the time lightning is sighted and the time thunder is heard. All players and spectators should have left the playing area before the flash-to-band count reaches 30 seconds. Play or practice should not continue until 15-30 minutes have passed after the last clap of thunder or flash or lightning.
  * If a severe thunderstorm watch or warning is issued during a game or within three hours of a game, the competition should be suspended and all players and spectators should move rapidly to safe shelter. If outdoors during a thunderstorm, players should avoid standing near structures in open areas, including tall objects that project above the landscape such as large isolated trees, water and grounded objects.
  * Wait at least 30 minutes after the storm has passed before returning to the game, or until the National Weather Service suspends the watch or warning.
  * When there is rain without a thunderstorm, teams usually play in spite of water and mud. Game officials and coaches must stay informed of the approach of severe weather and take cover early.
  * If a tornado watch or warning is issued during a game or within three hours of a game, the competition is usually cancelled. When there is a threat of a tornado, everyone should go indoors to the basement or lowest interior level of a building and crouch down with heads covered.
  * During extreme heat, professional games are usually played but coaches take precautions to protect players from heat illness/fatigue by providing plenty of cold water. If a player shows signs of heat illness, immediate medical attention is usually given. During extreme heat conditions, practice should include rest periods of 15 minutes/hour. Youth games are sometimes cancelled during very high risk conditions.
  * During extremely cold temperatures, the risk of exposed flesh becoming frozen is greatly increased at wind chill factors below -20 degrees Fahrenheit. Temperature, wind chill and degree of wetness are taken into account during cold weather.

Weather Observations: Should the Game Be Played?

- Students should check with the National Weather Service three hours prior to attending a football game or practice. Otherwise, watch the Weather Channel on television, look at the weather forecast in a recent newspaper, or check the weather on www.weatherchannel.com. Have them record the temperature, wind direction, wind speed, precipitation and barometric pressure. Based on the above information, ask the students if they think there is a reason the game could be cancelled, delayed or suspended?
- In the classroom, have students jot down hypothetical temperatures, wind directions, wind speeds, precipitation conditions and barometric pressures that will be read to the class. The class will discuss the fate of upcoming football games based on information provided.

Materials:

- Access to computers
- Access to the Internet (Weather websites)
- Pen/pencil
- Paper

Assessment:

- Students list the various weather factors that could affect the playability of a football game

What Happens to NFL Players' Heart Rate As Exercise Increases?

Goals/Objectives:

Students will:

- Demonstrate an understanding that the heart rate increases as exercise increases.
- Demonstrate an understanding that the heart rate increases because the heart needs to pump faster. This is because the heart needs more oxygen.

Next Generation Standards: LS1 - From Molecules to Organisms: Structures and Processes

Methods/Procedures:

- The class will talk about the functions of the heart. Students should be aware that the doctor uses a stethoscope to listen to their hearts.
- Students will either make a stethoscope out of 2 funnels and rubber tubing or use a real stethoscope.
- Students will measure two heart rates. The first one will be taken without any exercise, so students should be at rest. Have them take the heart rate for one minute. The second heart rate will be taken after students run in place for one minute (to symbolize NFL players' exercise during a game). The second heart rate should also be calculated for an entire minute.
- Students will compare their resting and exercising heart rate. Ask them why was there a difference? Students should realize that when you exercise you cause your heart rate increase. This is because more oxygen is needed, so the heart needs to pump faster.
- Students will complete the worksheet provided on the following page.

Materials:

- Stethoscope
- Paper to record heart rate
- Stopwatch or watch with second hand
- Worksheet: What happens to NFL Players' Heart Rate as exercise increases?

Assessment:

- Teacher Observation
- Completed Worksheet

What Happens to NFL Players' Heart Rate As Exercise Increases?

Directions: Look at each activity and determine if the heart rate would be normal or increased. Circle the correct answer.

Dancing

Normal Increased

Eating

Normal Increased

Running with a football

Normal Increased

Throwing a football

Normal Increased

Kicking a football

Normal Increased

Jogging

Normal Increased

Sleeping

Normal Increased

Watching Television

Normal Increased

What If Footballs Weren't Made of Leather?

Goals/Objectives:

Students will:

- Formulate tested hypotheses; develop and explain the appropriate procedures, controls and variables (dependent and independent) in scientific experimentation.
- Present scientific findings using clear language, accurate data, appropriate graphs, tables, maps and available technology.
- Use models to predict and analyze.
- Draw conclusions from inquiries based on scientific knowledge and principles, the use of logic, and evidence from investigations.
- Explain how new scientific data can cause any existing scientific explanation to be supported, revised, or rejected.

Next Generation Standards: PS1 - Matter and Its Interaction

Methods/Procedures:

- The teacher must create a scenario where a fictional character, player or interested individual is concerned that leather, an animal product, is used to make all NFL footballs. This individual, being an ardent vegetarian, believes that there have to be other choices and options available for football construction. As a beginning activity, each student will be asked to pretend he/she is this individual and state a hypothesis in writing. Then explain the procedures he/she must go through to test the hypothesis for a leather replacement football.
- Students will construct a chart comparing the leather football and the new ball including statistics such as ease of construction, passing capability, kicking capability and any other areas they feel the new ball and the traditional leather ball can be tested.
- The class will be convened so each student or group of students can present its findings from the experiment.
- Everyone's results will be charted so the class can either accept or reject the materials chosen as leather replacements.
- If a field trip can be made to the Hall of Fame, students will search for early and current examples of footballs used in the NFL and jot down observations and impressions

Materials:

- Teacher created scenario
- Traditional footballs
- Footballs of variously constructed materials
- Access to the Internet
- Access to HOF's website at ProFootballHOF.com

Assessment:

- Teacher and student created format (stencil) for student use and evaluation of variously constructed footballs.
- Students will deliver a formal presentation on their tested hypothesis.
- Teacher posts results and student experiments.

SCIENCE

What If Footballs Weren't Made of Leather

Name: Class:	Traditional 21st Century Football	Football Made From Plastics i.e. Pleather	Football Made From Wood
Distance: Football can be kicked			
Distance: Football can be passed			

What's the Matter With the Game of Football?

Goals/Objectives:

Students will:

- Examine objects, (matter) which could be found at a football game and categorize them based on various attributes, or physical properties
- Determine the materials the matter is made of and what the physical properties are for those materials (eg., solid, liquid, gas, or living, non-living)
- Demonstrate an understanding that objects can be classified in more than one way because all objects have more than one property

Next Generation Standards: PS1 - Matter and Its Interaction

Methods/Procedures:

- The teacher asks for the definition of matter to see if there is a consensus, (anything that takes up space and has weight) and asks for examples. Come to the consensus that every object or substance in the universe is made up of matter.
- The teacher then explains or reviews that the characteristics that help us describe and identify matter are called properties. Explain that in this lesson, students will be looking at objects by determining the materials they are made of and considering the physical properties of those materials. Point out that physical properties are observable with the use of the five senses.
- Have students brainstorm some physical properties, and then the teacher might decide which to focus on, or narrow the focus. Generate examples such as, color, texture, state of matter (solid, liquid, gas), living/nonliving, man-made/ natural, hardness, compound, bio-degradable/ non-bio-degradable, etc. There is room for differentiation in this list.
- The teacher has either pictures or preferably, actual objects on a table. They include items found in football, such as, a metal whistle, a shirt, a paper cup filled with water, a napkin, a football, a football helmet, water in a plastic jug, a band aid, leather gloves, metal goal posts (made of metal pens taped together), people (fans and/or players and coaches), program with players' names and stats, wooden benches (made of popsicle sticks glued together), grass from the field, paper ticket, etc. There is a yes/no label on a desk or table in front of the room.
- Students will need their notebooks or journals to serve as "Research Notes" for this activity.
- Students will draw the following diagram from the board into their "Research Notes."

Yes	NO

Concept_____

What's the Matter With the Game of Football?

- Place students in groups of 3 or 4. Explain that each group will be looking for similarities in the objects shown based on the designated physical properties generated by the students and teacher. The groups will figure out what the items have in common and what attributes the items do not share. The concept or property they are basing this on should be written in their notes under the diagram.
- The teacher shows one item at a time by holding it up in front of the class or walking around the classroom. Students may touch the objects. No writing is done at this time.
- Have the items on a table so that groups can see all of them together to help them see what properties they have and do not have in common.
- Place each item as it is shown, on a table surface marked with YES or NO signs based on student responses. Begin with 3 or 4 more obvious items, and move on to the less obvious. Let the students develop their own ideas in groups and listen to their proposals.
- Hypothesize/Propose the Concept: As the activity proceeds, tell students to try to determine the concept being illustrated, and jot it in the data sheet (above).
- Explain that when students think they know the concept, they should continue to add items to each side of the diagram. The groups need to continue with items until they have all been recorded and "placed" by the students.
- CONFIRM THE CONCEPT: Determine who has a viable prediction of the concept. Ask the student how he/she made the determination. Ask for explanations…biodegradable, non-bio-degradable, or living, non-living.
- Ask students to list the characteristics or attributes of the YES items. Compare these items with the concept.
- Assign students to work with a partner to compare their lists. Reconcile them to make a common list. Ask students to add new examples to their YES list, making sure that the new items listed have the same attributes as the objects originally listed, and that they all have a place in football games.

Materials:

- Pen/Pencil
- Notebook or Journal
- Items found at a football game

Assessment:

- Check the chart for accuracy. Then have the students write an extended response explaining why the items chosen have the property and why the others don't.
- The teacher adds additional items from a football game and students place these under YES or NO based on a concept, or property.

SCIENCE

What's Your Reaction Time?

Goals/Objectives:

Students will:

- Understand what reaction time is.
- Determine their own reaction time.

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- Students will begin by listening to this story: "It's the 4th quarter of the football game with only 15 seconds to go. The Pittsburgh Steelers (or any other team you choose) are playing the Cleveland Browns (or any other team you choose). The game is tied. One player from the Cleveland Browns is standing by the end zone waiting for the football to be passed to him. All of a sudden a Pittsburgh Steeler comes out of nowhere and tries to tackle him right as the ball is coming his way. What should he do- jump to catch the ball or run out of the way?"
- Have students brainstorm what he should do. The students should end up discussing how he has to react very quickly with a decision. Ask students: What is it called when you have to quickly react? How long does it take to react to a situation like this?
- Introduce the term reaction time. Explain to students that reaction time is how quickly you can react to a situation. For example, you see your pencil rolling off of your desk. Maybe your dog runs out into the middle of the street when cars are coming. How quickly can you catch your pencil or get your dog?
- Teacher should share with students that when your eyes see a situation occurring, it needs to send a message to your brain, which then sends a message to the necessary muscles to react.
- Discuss other situations that may occur in a football game in which the players need to make quick reactions? What are other situations in students' lives?
- Have students perform the following activity to see how fast their reaction time is:

  Experiment Directions:

  1. Students will place hand at the end of a table with palm facing up. Hold out fingers and thumb so that there is a 3 inch space between them. Student should make sure that his/her fingers and thumb are exactly 3 inches apart because if some aren't, their times wouldn't be reliable.
  2. A friend will hold a ruler between the student's thumb and fingers (without touching them) so that the beginning of the ruler is lined up at the top of the student's thumb.
  3. Without any warning, the ruler will be dropped. The student is to catch the ruler between his/her thumb and forefingers as quickly as possible.
  4. Record the number on the ruler where the student caught the ruler. Record how far up the ruler the subject caught it. Redo this activity 2 more times. The lower the number, the quicker the reaction time.

What's Your Reaction Time?

- After students perform this experiment pose several questions: Do you think your time is fast enough to be an NFL player? Is it possible to change your reaction time?
- Teacher can extend this activity to have students create a class graph and find measures of central tendency with the data.

Materials:

- Ruler
- Paper and pencil for recording reaction time

Assessment:

- Discussion
- Ability to perform activity

How Much Can Be Recycled?

Goals/Objectives:

Students will:

- Explain how technology influences the quality of life.
- Discuss how decisions about the use of products can result in desirable or undesirable consequesces.
- Use examples to predict and analyze.
- Recognize that science can only answer some questions and technology can only solve some human problems.
- Describe examples of scientific advances and emerging technologies and how they impact society.

Next Generation Standards: ESS3 - Earth and Human Activity

Methods/Procedures:

- The students and teacher will compile a list of objects that accumulate from fans, players and workers at any NFL game.
- Students gather, if possible, concrete examples of listed items.
- Students determine which listed objects can be recycled.
- Through letters, calls, emails, and possibly personally, determine which stadiums recycle and what items they recycle.
- After compiling all three lists, using a mathematical formula, including amount of each product sold, students determine the weight of each recyclable item/team's game and or season through extrapolation.

Materials:

- Students and teacher created item list
- Access to the Internet
- Access to HOF's website at ProFootballHOF.com
- Scales for weighing objects

Assessment:

- Student created tables of items sold, recyclable items, items recycled and total poundage.
- Students will deliver a formal presentation on their findings.
- Teacher posts results and student findings (charts).

How Much Can Be Recycled?

Lambeau Field (Green Bay, WI)

Items Sold	Item A	Item B	Item C	Item D
Game 1	Total Weight:	Total Weight:	Total Weight:	Total Weight:
Game 2	Total Weight:	Total Weight:	Total Weight:	Total Weight:
Game 3	Total Weight:	Total Weight:	Total Weight:	Total Weight:

Students may add items, delete items, add games, delete games depending on time constraints.

Which NFL Cities Have The Most Rainfall?

Goals/Objectives:

Students will:

- Graph the amount of average monthly rainfall for each NFL city.
- Compare the average monthly rainfall of NFL cities.
- Draw a picture of the city during football season.

Next Generation Standards: ESS2 - Earth's Systems

Methods/Procedures:

- Students will discuss where NFL cities are located and find the cities on the map.
- Teacher will let the students (individually or in pairs) choose a city to research.
- Students will access the Internet or use another reference material to determine the amount of average monthly rainfall of that city. They will fill in the bar graph on the next page.
- They will then draw a picture of football players playing a game in that climate during football season.
- Students will compare the similarities and differences among the cities

Materials:

- Internet access
- Classroom map
- Worksheet

Assessment:

- Worksheet
- Discussion

SCIENCE

Which NFL Cities Have The Most Rainfall?

Directions: Complete a bar graph of monthly rainfall in your NFL city.

Average Amount of Monthly Rainfall

_____

(Name of City)

Inches												
	January	February	March	April	May	June	July	August	September	October	November	December
Months												

This is a picture of football players in my city during football season.
(Make sure you include what the weather will look like.)

SCIENCE

Which NFL Cities Have The Most Rainfall?

AFC	NFC
Baltimore Ravens Baltimore, Maryland	Arizona Cardinals Glendale, Arizona
Buffalo Bills Orchard Park, New York	Atlanta Falcons Atlanta, Georgia
Cincinnati Bengals Cincinnati, Ohio	Carolina Panthers Charlotte, North Carolina
Cleveland Browns Cleveland, Ohio	Chicago Bears Chicago, Illinois
Denver Broncos Denver, Colorado	Dallas Cowboys Arlington, Texas
Houston Texans Houston, Texas	Detroit Lions Detroit, Michigan
Indianapolis Colts Indianapolis, Indiana	Green Bay Packers Green Bay, Wisconsin
Jacksonville Jaguars Jacksonville, Florida	Los Angeles Rams Los Angeles, California
Kansas City Chiefs Kansas City, Missouri	Minnesota Vikings Minneapolis, Minnesota
Las Vegas Raiders Las Vegas, Nevada	New Orleans Saints New Orleans, Louisiana
Los Angeles Chargers Los Angeles, California	New York Giants East Rutherford, New Jersey
Miami Dolphins Miami Gardens, Florida	Philadelphia Eagles Philadelphia, Pennsylvania
New England Patriots Foxborough, Massachusetts	San Francisco 49ers Santa Clara, California
New York, Jets East Rutherford, New Jersey	Seattle Seahawks Seattle, Washington
Pittsburgh Steelers Pittsburgh, Pennsylvania	Tampa Bay Buccaneers Tampa, Florida
Tennessee Titans Nashville, Tennessee	Washington Commanders Landover, Maryland

Motion and Forces in the NFL

Goals/Objectives:

Students will:

- Explore the Pro Football Hall of Fame through the website and/or field trip.
- Find real life examples of the motions and forces as they apply to the NFL.
    - Identify balanced and unbalanced forces.
    - Identify examples of Newton's first, second and third law of motion.
    - Find examples showing how force and mass are related to acceleration.
    - Find evidence of friction and how it applies to football.
    - Find evidence to support the presence of gravity.

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- Students are to create posters, displays, PowerPoints or other forms of multimedia that support the goals and objectives of the lesson.
- Students will start with ProFootballHOF.com to find resources.
- Students will use the NFL.com to find additional information, pictures, graphics or any other materials and information needed to complete the goals and objectives of the lesson.
- If able to, a visit to the Pro Football Hall of Fame may be used to gather information.
- A summation of the lesson will be written in paragraph format. This summation will address each of the goals and objectives including an explanation of each of the examples.
    * Identify balanced and unbalanced forces.
    * Identify examples of Newton's first, second and third law of motion.
    * Find examples showing how force and mass are related to acceleration.
    * Find evidence of friction and how it applies to football.
    * Find evidence to support the presence of gravity.

Materials:

- Students may use a variety of materials to complete the lesson.
- Material selection will be determined by the type of presentation used.

Assessment:

- Student/Teacher created scoring rubric for the presentation and written summation

Movement and Motion in the NFL

Goals/Objectives:

Students will:

- Review how objects can be moved in a variety of ways such as straight, zigzag, circular and back and forth
- Review how objects can be affected by pushing or pulling

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- Children can be encouraged to look throughout the Pro Football Hall of Fame to find examples of how objects move.
- Children can complete a My Pro Football Hall of Fame Movement and Motion Booklet.
- Children write their own sentences or additional sentences on the bottom of each page. The sentences can give additional details and/or definitions.
- If not able to visit the Hall of Fame, visit https://www.nfl.com/100/originals/100-greatest/plays-51 to view a video on Hall of Fame Running Back Barry Sanders.

Materials:

- My Pro Football Hall of Fame Movement and Motion Booklet
- Barry Sanders Video

Assessment:

- Teachers or class can create a rubric to fit the needs of the class

SCIENCE

Movement and Motion in the NFL II

Goals/Objectives:

Students will:

- Review how objects can be moved in a variety of ways such as straight, zigzag, circular and back and forth
- Review how objects can be affected by pushing or pulling.
- Use technology to research and create

Next Generation Standards: PS2 - Motion and Stability: Forces and Interactions

Methods/Procedures:

- The teacher can use NFL.com and/or the Pro Football Hall of Fame's website, ProFootballHOF.com, to locate examples of how objects move as well as objects being pushed or pulled.
- Students can demonstrate how objects move and objects being pushed or pulled by using a football.
- The students can use tablets or computers to locate and print examples of how objects move and objects being pushed or pulled in the sport of football.
- Students can work individually or in teams to create slide shows, books, posters or dioramas.
- If able, the amount of change in movement of an object depends on the mass of the object and the amount of force exerted can be labled.
    * Add photos or draw pictures of objects of varying mass or varying force applied.
    * For example, a kicker's foot kicking the football would show the varying force on an object. Discuss what happens with a light kick as opposed to a hard kick.

Materials:

- Access to NFL.com and/or ProFootballHOF.com by computer
- Objects that can be pushed or pulled
- Possible need for tablets
- Football

Assessment:

- Teacher or class can create a rubric based on class needs

My Pro Football Hall of Fame Movement and Motion Book

Name _____

Date _____

My Movement and Motion Book

This is an example of straight movement.

Explain:

My Movement and Motion Book

This is an example of zigzag movement.

Explain:

My Movement and Motion Book

This is an example of circular movement.

Explain:

My Movement and Motion Book

This is an example of a back and forth movement.

Explain:

My Movement and Motion Book

This is an example of an object being pushed.

Explain:

My Movement and Motion Book

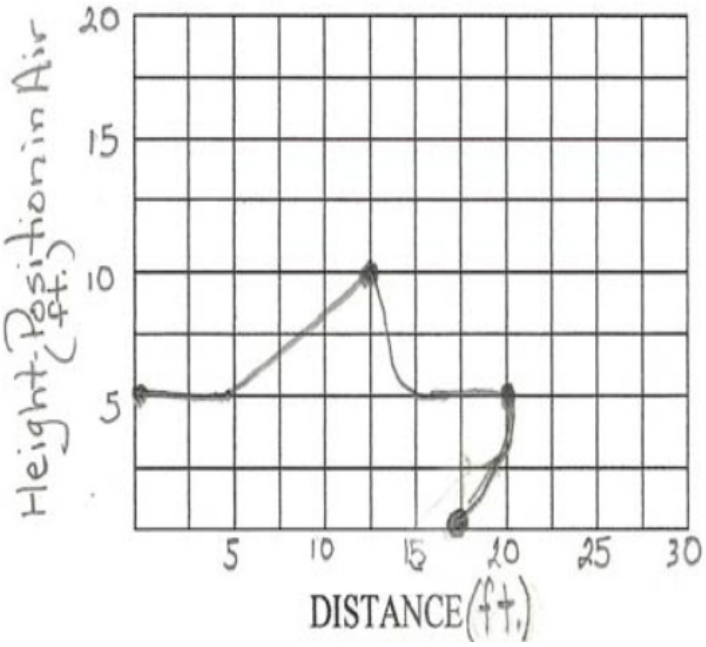
This is an example of an object being pulled.

Explain:

Answer Key

Momentum and Football

1. The ball carriers in Scenarios #1 and #2 will score. The momentum of these ball carriers is greater than those of their defenders. Thus, the ball carrier/defender unit will move toward the goal line.
2. The defender in Scenario #4 has the greatest momentum. The velocity of this player is the most significant factor in giving this defender the greatest momentum of all the defenders because the other defenders are all more massive that this one.
3. The offensive player's momentum changes the most because he stops and is pushed backward by the defensive player whose velocity is greater.
4. The total momentum is not affected by the collision. According to the law of conservation of momentum, the momentum of any closed, isolated unit does not change. The pairs of players in each scenario make up such a unit.



Newton's Law