

Physical Properties of Sports Equipment

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Big Idea for Physical Education	Big Idea for Science
Movement Competency	Properties of Matter
Standards	
<p>PE.4.M.1.7: Move in different directions to catch objects of different sizes and weights thrown by a stationary partner from varying distances.</p> <p>SC.4.P.8.1: Measure and compare objects and materials based on their physical properties including: mass, shape, volume, color, hardness, texture, odor, taste, and attraction to magnets. (R/E – investigate the concept of weight versus mass of objects).</p>	
Learning Goals for integrated lesson plan	
<p>The student will:</p> <ul style="list-style-type: none"> • measure and compare objects and materials based on their physical properties. • be able to define mass, shape, volume, and weight. • explain how weight and mass affects throwing and catching objects of differing physical properties. 	
Vocabulary common to both disciplines	
<ul style="list-style-type: none"> • shape • mass • texture • gravity • force 	
Bringing PE equipment into science classroom	
<p>In PE, students will use their prior knowledge of weight and mass to analyze objects of various shapes and sizes. They will determine which objects will be able to be thrown the greatest distance and which objects will be thrown the shortest distance.</p> <ul style="list-style-type: none"> • How can the shape and size of an object determine how far it will travel when thrown by someone? • How would different forces be used to throw objects of different sizes and weights? 	
Summary of Physical Education Activity	Summary of Science Investigation
Students will use their reasoning skills to determine how the weight and mass of an object will affect the distance that the object will travel when thrown by an individual.	Students will observe different sports balls to identify its physical properties and determine how the properties fit the purpose for which it is being used.
Common Misconceptions	
<p>While the science standard addressed in this integrated lesson plan refers to the mass of an object, the PE standard refers to objects of different weights. This is a complicated scientific concept. Weight actually refers to the amount of force pulling down on the object. An object with more weight has more force pulling it down. Mass, on the hand, refers to the amount of matter that is in an object. While weight is impacted by gravity, mass is not. In other words, the weight of a football would change if it was taken to the Moon, but the mass</p>	

of it would not change. The difference between weight and mass isn't taught in the science classroom until middle school, but all teachers should be aware of the possible confusion that might arise. One possible way of addressing this is to help students understand that increasing mass would have a corresponding increase in weight.

Assessment Tools - PE	Assessment Tools - Science
Teacher observation, cooperative learning strategies, exit ticket	Discussion, CER and Science journal

Physical Education: Adding Weight

Duration of Lesson
40 Minutes
Materials
<ul style="list-style-type: none"> ● running area ● various objects of different shapes, sizes, and weights
Procedure
<p>Introduction and Engagement: Today we are going to explore the concepts of weight and how that concept can have a dramatic effect on how we can throw and catch objects of varying weights.</p> <p>Warmup Activity</p> <p>Preparation:</p> <ol style="list-style-type: none"> 1. Prepare an area for students to be able to jog safely in an open space. 2. Have objects of different sizes and weights. Examples: <ol style="list-style-type: none"> a. sand weights b. plastic milk jugs filled with sand c. backpacks with books inside d. anything that will add weight that the students can safely jog around with <p>Procedure:</p> <ol style="list-style-type: none"> 1. Question: What makes up the mass in our bodies? (Water, bones, and muscles make up most of the mass of our bodies.) Does the weight of our bodies affect us when we run? Let's give this a try and see what happens. 2. Activity - Have students jog a short distance or for a short period of time. After students have completed the jog, ask them a few questions about how they feel: <ol style="list-style-type: none"> a. What are some of the changes that occurred in your body that let you know that you were jogging? 3. After the discussion, have students select any of the objects available that has additional weight. Students will then be instructed to jog the same distance or the same amount of time as before. 4. When students have completed the jog ask them how they felt while carrying the object: <ol style="list-style-type: none"> a. What are some of differences from the first jog to the second jog? This should lead into a discussion about how a heavier weight will slow us down and force our bodies to work harder to carry the added weight.

Activity #1 Partner Toss

Preparation:

Have a small area set up that has numerous objects of varying sizes and weights. Objects can be placed in a bin, hula hoops, or a corner of the area. Make sure there is a large enough area for this activity for students to safely pass and catch object with a partner without interfering with others.

Procedure:

1. Have students select a partner and stand toe to toe with their partner. Have the partners play one game of rock, paper, scissors. The winner of RPS goes to the area with the object to toss and catch and selects one object and returns back to their partner. Instruct the students that when the music begins they are to spread apart from each other and safely throw and catch the object. Everyone shall be actively engaged with throwing and catching with their partner.
2. When the music stops the partner without the object sits down while the partner with the object has 10 seconds to trade objects with another student and return back to their original partner. When the music begins the students again begin to toss and catch the object.
3. For the final episode in this activity the students will play Toss 3. When the music begins, the students will toss the object with their partner 3 times. After the third toss the partner with the object remains stationary, while the partner without the object must quickly find a new partner to toss and catch with 3 times. Repeat this tossing and catching movement until the music stops.
4. When the music stops instruct the students to return the objects back to the area where they got them and to gather in front of the teacher and sit down. Briefly lead the students into a discussion about the objects that they used to throw and catch. Why were some objects easier to pass and catch? How did the weight and mass of the objects affect the throw of it? These questions should lead into a discussion of how the weight, mass, size, and density of an object can impact the distance that it travels when it is thrown.
5. On a projector or printed out sheets of paper show students pictures of some of the balls or objects that they were throwing with them cut in half to show the inside of the object. Some examples might be: tennis ball, baseball, lacrosse ball, football, basketball, etc. Discuss the weight and density of the objects and how it relates to each sport that it represents. Why would a tennis ball not be a good ball to use in the game of baseball? Why would a baseball not be a good ball to use in tennis?

Activity #2 Cross the Line

Preparation:

In a large open area create a starting line and a finish line. The lines should be at least 30 yards or more apart. Starting and finish lines could be marked with cones, ropes, or any other clearly visible markers that would signify a starting location and a finish location.

Procedure:

1. Have students select a partner and 3 objects to throw and catch. Have students select objects that have different shapes, mass, density, and weight. All of the objects should be different.
2. Students will analyze the physical properties of the objects. What makes each object different?
3. Objective is to throw and catch each object one at a time from the starting line to the finish line. One student will start as the thrower and the other student will be the receiver. When the thrower tosses the object and the receiver catches it, the thrower then jogs to a location in front of the receiver. The receiver then becomes the thrower and the thrower becomes the receiver. Partners continue this pattern until they reach the finish line.
4. When the partners reach the finish line with the object they perform a locomotor movement that they choose and return back to the starting line and select another object. Continue in the same throwing and catching pattern as detailed above. When they reach the finish line, perform a different locomotor movement back to the start and continue with the last object remaining.

5. Before the students begin to throw and catch each object, have them both estimate how many throws it will take them to reach the finish line.
6. If the receiver does not catch the object, the receiver picks up the object and then returns it back to the thrower and they try again. They may not advance until the object is caught.
7. Variation: Give all groups a 5 minute time limit. How many times can they reach the finish line with all 3 objects in the time limit. Each time they get the 3rd object to the finish line, they give themselves a point and return all 3 objects back to the starting line and begin again.

Closure/Assessment:

1. Have students answer the following questions relating to the activities that they completed. Students could answer the questions verbally to the teacher in a question and answer format; clipboard, paper, pencil; or they could answer the questions via google classroom.
2. How did the weight and mass of the object affect the way it was thrown? Describe how the physical properties of a ball/object affect the distance that it travels when it is thrown. Compare and contrast the properties of a baseball and a tennis ball.

Science Investigation: Properties of Sporting Balls

Duration of Lesson

1 hour 30 minutes

Materials

- scale
- measuring tape
- bucket or bin
- variety of sports balls
- chart paper
- markers
- bin full of different sports balls (soccer, volleyball, tennis, ping pong, racketball, softball, golfball, basketball, badminton, lacrosse, kickball, hockey puck, etc.)
 - Ask the PE teacher for a variety of sports balls or ask the students to bring in different balls.
- Evolution of the Football student sheet - 1 per student (attached)
- Evolution of the Football CER student sheet - 1 per student (attached)
- C-E-R Directions/Rubric - 1 per student (attached)

Teacher Notes

Background: Physical properties can be observed or measured without changing the composition of **matter**. **Physical properties** are used to observe and describe **matter**.

- **Observable physical properties** are properties in which you use your five senses to get information about an object. If you can describe the matter based on what it looks, feels, smells or tastes like, you are describing the physical properties.
- **Measurable properties of matter** are properties that must be measured with a tool (ruler, beaker, graduated cylinder, scale, etc.). Types of measurable physical properties include: mass, shape, volume, color, hardness, texture, odor, taste, and attraction to magnets. Observable properties

Discussion Questions:

- What are some properties of matter?
- How do people use properties of matter?
- Why is it important to be able to measure different types of matter?
- What can you observe with just the human eye?
- What kinds of tools would be useful when measuring matter?

Now that we have learned the properties, students could easily turn this into science fair projects:

- If I changed a property (wet/dry, surface, amount of air, etc.), how would it affect the function?

Procedure

Engage:

1. Divide students into small groups (3 or 4 students). Give each group a bag or box with a random object inside (all objects should be different). Explain to the class that the groups will have three minutes to brainstorm a list of words in their science journals to describe the object in as many ways as they can without saying the name of the object.
2. Next, have each group share their list of descriptions of their object to other groups- and the other groups will try to guess what object they have just described.
 - a. If, after a group presents, the object is guessed correctly, discuss which words helped the class make their inferences about what was in the bag?
 - b. If the object is guessed incorrectly, discuss what properties would have helped the class to better understand what was in the bag.
3. Have students look at the words from their list and group the words into categories (color, texture, shape, etc.)

Explore #1: Properties of Sports Balls

1. Hold up a sports ball (for example, a basketball) and ask the students what sport this ball could be used for.
2. Challenge the students to think of more than one sport.
3. Then ask why this ball would be good for these sports. What are the properties that make the ball fit with the sport?
4. Then ask: Which sports will it not be good for and which properties make it unfit for that sport?
5. Break the students into teams of 2-3 students.
6. Have each team pick a random sports ball from a bin. Have each team observe the physical properties of their sports ball. (Have different tools available for students to use to measure and observe the properties.)
7. Give each team a sheet of chart paper to create a poster for their sports ball, identifying the physical properties that are the most needed for their function. How do those properties help them meet their functions of their sport.
8. When all teams have finished, put all the balls back in a bin. Hang the posters around the room so that all posters are visible for the teams.
9. Each team will grab a random ball (not their own) and try to match the correct sports ball to the correct poster.
10. Ask, "What sport would it not be good for?" An example is, "A golf ball would not be good for playing baseball because..."

11. Discuss the following questions in groups:

- What are some properties of matter?
- How do people use properties of matter?
- Why is it important to be able to measure different types of matter?
- What can you observe with just the human eye?
- What kinds of tools would be useful when measuring matter?

Explore #2: Evolution of the Football

1. Display the evolution of the football pictures using the following link. Hand out the Evolution of Football student page. <https://www.profootballhof.com/photos/gallery/the-evolution-of-the-football/>
2. Have students work in pairs to observe the properties of each of the different types of football and record their observations on their Evolution of the Football student page.
3. Have the student make inferences about why they think the properties changed over the years.

Explain:

1. Have the students read the following articles and highlight the properties of a football and how they impacted its function over the years.

Articles:

- <https://boyslife.org/features/151034/how-the-football-has-changed-since-1869/>
- <https://www.sporttechie.com/the-evolution-of-the-football/>
- <https://www.smithsonianmag.com/arts-culture/how-did-the-pigskin-get-its-shape-63180450/>
- <https://www.businessinsider.com/advantage-of-deflated-footballs-2015-1>

2. After reading the article, hand out *Evolution of the Football* CER (Claims, Evidence, and Reasoning) Student Sheet. The students will write a response to this question:

Was the under-inflation of the footballs by the New England Patriots cheating? Use evidence from the articles to support your thinking.

Extentions:

- <https://hubpages.com/games-hobbies/Different-types-of-balls-and-their-specialties>
- <https://bleacherreport.com/articles/1663740-how-the-evolving-science-of-ball-design-has-changed-football>
- <https://www.hibbett.com/hibbett-university/sports/how-to-choose-the-right-soccer-ball.html>

Name: _____ Date: _____

The Evolution of the Football

Did you know that the football was never really truly designed? It just sort of happened over the years. Observe the pictures of the football from the football hall of fame and record the properties below in the chart. Explain how the properties of the football fit its function.

1894	Describes the football's Properties	How does it meet its Function
1911	Describe how its properties have changed	How does it better meet its function
1929	Describe how its properties have changed	How does it better meet its function
1956	Describe how its properties have changed	How does it better meet its function
1958	Describe how its properties have changed	How does it better meet its function
1960-1969	Describe how its properties have changed	How does it better meet its function
1990-2005	Describe how its properties have changed	How does it better meet its function
2006-Present	Describe how its properties have changed	How does it better meet its function

Name: _____ Date: _____



Evolution of the Football CER



After reading the articles, answer the following CER (Claims, Evidence and Reasoning) response:

Was the under-inflation of the footballs by the New England Patriots cheating? Use evidence from the articles to support your thinking.

Evidence:

Use the Claims-Evidence-Reasoning framework to make your claim and write your response.

Claim	Restate and answer the question or problem.
Evidence	Use evidence from your text. <ul style="list-style-type: none">• <u>Sufficient</u>: enough to support your claim• <u>Appropriate</u>: the BEST evidence to support your claim
Reasoning	THE MOST IMPORTANT PART! Ties your evidence to your claim <u>How</u> or <u>Why</u> your evidence supports your claim

C	
E	
R	

Claim - Evidence - Reasoning Directions/Rubric

Claim: This is what you think is happening or caused something to happen in the scientific investigation.

Evidence: These are your observations from the investigation (what you see, hear, smell, or feel).

Reasoning: This explains how your observations led to your claim. What made you decide on THIS claim? Make sure you use science words and concepts in your explanation.

This is how it will be scored:

	4 points	3 points	2 points	1 point	0 points	Total for category
Claim	Response restates the question and gives full, detailed, correct claim.	Response restates the question and gives a correct claim, but answer lacks completeness.	Response makes a correct claim, but doesn't restate the question.	Response restates the question, but makes no claim.	No claim is made.	_____ x 3 = _____
Evidence	Response gives at least two pieces of evidence that directly and fully support claim.	Response gives at least one piece of evidence that support claim AND a second piece that only partially supports claim.	Response gives one piece of evidence; that evidence directly supports claim.	Response gives evidence that only partially supports claim.	No evidence given.	_____ x 4 = _____
Reasoning	Reasoning clearly and convincing explains why each piece of evidence supports claim.	Reasoning explains why one piece of evidence supports claim AND includes partial reasoning for second piece of evidence.	Reasoning somewhat explains why evidence supports claim.	Reasoning is general and non-specific.	No reasoning given.	_____ x 5 = _____
Conventions	Conventions are appropriate for 5 th grade.	Some minor lapses in conventions occur.	Major lapses in conventions	Convention errors make it difficult to understand response.		____ x 2 = _____
Total for CER						____ /56