LESSON PLAN

Making Forces Easy

Teacher Notes:

Next Generation Sunshine State Standards:

SC.3.E.5.4- Explore the Law of Gravity by demonstrating that gravity is a force that can be overcome
SC.3.P.10.2- Recognize that energy has the ability to cause motion or create change

SC.4.P.10.1-- Observe and describe some basic forms of energy, including light, heat, sound, electrical, and the energy of motion.
SC.4.P.10.2-- Investigate and describe that energy has the ability to cause motion or create change
SC.4.P.12.1-- Recognize that an object in motion always changes its position and may change its direction
SC.4.P.12.2-- Investigate and describe that speed of an object is determined by the distance it travels in a unit of time and that objects can move at different speeds

SC.5.N.1.2-- Explain the difference between an experiment and other types of scientific investigation
SC.5.N.1.3-- Recognize and explain the need for repeated experimental trials
SC.5.P.13.1-- Identify familiar forces that cause objects to move, such as pushes or pulls, including gravity acting on falling objects
SC.5.P.13.2-- Investigate and describe that the greater the force applied to it, the greater the change in motion of a given object

Common Core Literacy Standards:

CCSS.ELA-Literacy.RST.6-8.1-- Cite specific textual evidence to support analysis of science and technical texts.
CCSS.ELA-Literacy.RST.6-8.2-- Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
CCSS.ELA-Literacy.RST.6-8.3-- Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
CCSS.ELA-Literacy.RST.6-8.4-- Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6–8 texts and topics*.
CCSS.ELA-Literacy.RST.6-8.7-- Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
CCSS.ELA-Literacy.RST.6-8.8-- Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
CCSS.ELA-Literacy.RST.6-8.9-- Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

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CCSS.ELA-Literacy.RST.9-10.1- Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
CCSS.ELA-Literacy.RST.9-10.3-- Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCSS.ELA-Literacy.RST.9-10.4-- Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
CCSS.ELA-Literacy.RST.9-10.8-- Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

CCSS.ELA-Literacy.RST.11-12.3-- Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
CCSS.ELA-Literacy.RST.11-12.4-- Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
CCSS.ELA-Literacy.RST.11-12.7-- Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Common Core Mathematics Standards:

CCSS.Math.Content.HSS-IC.B.6-- Evaluate reports based on data.

Target Classes:

- Elementary School Physical Science, especially 5th grade
- Middle School Physical Science

Summary of the Activity:

The following activity introduces students to the concept of mechanical advantage as it applies to simple machines and the human body. The worksheet has students visit the ***Wonder Park, Pull Yourself Up, and How High Can You Jump*** exhibits.

Timing:

Approximately 45 minutes of data collection at ***WonderWorks***

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Pre-Field Trip Activities:

- Students should be familiar with the concept of forces, including the forces of gravity, pushing, and pulling.
- Students should also be familiar with pulleys and levers, if only on a conceptual level.
- While this worksheet can be used as guided inquiry to introduce the concept of mechanical advantage, it may be helpful for some students to be introduced in the classroom to the concept of mechanical advantage.
- Before going to ***WonderWorks***, it may be useful to go over the ways of pitching and jumping with constricted movement to clarify any misconceptions about the directions.

Post-Field Trip Activities:

- Discussion questions stemming from this activity include:
    - What is the purpose of pulleys, levers, and other simple machines?
    - What are some simple machines you use every day that provide you with mechanical advantage?
    - How does your body provide you with a mechanical advantage? What are some body parts that provide you with a mechanical advantage?

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Student Worksheet

A **force** can be thought of as either a push or a pull. The unit used to measure the strength of a force is a Newton (N).

Choose three stations and determine what types of forces are used in each station. Some stations may use pulling, pushing, or a combination of both. Then in the boxes below, label the name of the station and draw the forces that are being used. Be sure to draw the object that you are pushing or pulling, or the object that is pushing or pulling you.

Station:	Station:	Station:

Some forces cause objects to move. Isaac Newton, a famous scientist who lived from 1642-1727, studied how forces can affect the movement of objects. He wrote down his observations as "Newton's Three Laws of Motion." Today we will be studying how forces can affect the movement of objects by visiting three stations: **Wonder Park**, **Pull Yourself Up**, and **How High Can You Jump**. We will be doing experiments at each of these stations.

Visit "Wonder Park" (2nd Level)

Start by placing the ball on the ground. What is keeping the ball on the floor?

_____

WONDERWORKS™
LET YOUR IMAGINATION RUN WILD !

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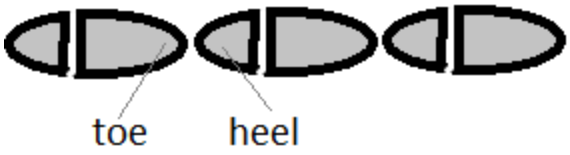
Newton's First Law of motion says that an object at rest (that is not moving) will continue to be at rest until it is disturbed by a force. When you pick up the ball, are you applying a force on the ball? If so, what direction is the force in? In what direction does the ball move?

_____

_____

_____

Next, we are going to throw the ball and measure both its speed and the distance that it travels. The speed of the ball will be displayed on the screen after you throw it. We will be measuring the distance that the ball travels in terms of steps. When measuring these steps, place the heel of your foot at the toes of your other foot, and take small, careful steps. Try to make sure that every step is the same size.



The first time you throw the ball, you will not be moving your entire arm. Start by tucking your elbow by your side. Throw the ball without moving your upper arm or shoulder. Record the speed and distance in the table below.

The second time you throw the ball, you may throw as you would normally. You can move your entire arm, including your shoulder. Record the speed and distance in the table below.

Data

	Speed (in mph)	Distance (in steps)
Throwing the ball with your elbow tucked in (not moving your arm)		
Throwing the ball normally (moving your whole arm)		

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You should have noticed that one way of throwing the ball gave you a much faster pitch. It also should have made the ball travel much farther. When one method of applying a force makes an object move faster or farther, we say there is a **mechanical advantage**. A machine that gives a mechanical advantage can make things travel faster, farther, or can make pushing or pulling them easier.

Which way of pitching the ball gave you a mechanical advantage?

_____

_____

_____

Visit "Pull Yourself Up" (2nd Level)

Pulleys may look modern, but they are an ancient invention that is used because it gives a mechanical advantage! Using pulleys makes it easier to pull objects and lift them up.

Sit at each of the seats at the pull yourself up station and try to lift yourself up.

Which seat is the easiest to lift yourself up from? _____

Which seat is the most difficult to lift yourself up from? _____

What is the difference between the three seats and why does it make it easier to lift yourself on some?

_____

Which station had the greatest mechanical advantage? _____

Which of the three stations used the most amount of rope when pulling yourself up? _____

Visit "How High Can you Jump" (2nd Level)

Once again, we are going to do two different experiments to show mechanical advantage.

In the first experiment, try to jump without bending your knees on the way up or down. Record how high you jump (in inches) in the table below.

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In the second experiment, you can jump as you naturally would, bend your knees like normal. Again, record how high you jump in the table below.

	Height jumped (in inches)
Jumping without bending knees	
Jumping with knees bent	

Which way of jumping gave you the greatest mechanical advantage?

_____

_____

Tying it all together

Your body has amazing ways of giving you mechanical advantages. Can you think of three body parts that offer you a mechanical advantage? What are they and what do they do?

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