BALANCED & UNBALANCED FORCES

differentiated passages

LEXILE

480L

Name: _____ Date: _____

Newton's Discovery of the Laws of Motion

Gravity is an invisible force. It pulls objects toward each other. Gravity makes something you drop fall to the ground. Forces, gravity, and motion are all a part of your life.

Isaac Newton

How do we know about these ideas? Sir Isaac Newton helped. He was born on January 4, 1643, in England. Newton didn't want to be a farmer like his father. He stayed in school instead. He went to the University of Cambridge's Trinity College in 1661. In 1665, a sickness closed the college. Newton spent time back at his home. He kept learning, though. He made many theories, or ideas, about science and mathematics.

Newton spent much time alone. It was said he sat below an apple tree. An apple may have fallen on him. He thought about forces and motion after this. He studied objects. He tested what forces act on them. He learned how those forces affected the objects. Newton's experiments led to his understanding of gravity. He used it to describe the movements of the planets and the sun. He developed his three laws of motion in 1666.

Newton's three laws of motion have been proven by other scientists. The laws have led to many different inventions. Humans are able to travel into space because of Newton's laws. Sir Isaac Newton died on March 31, 1727. His discoveries live on. They affect your everyday life.

Newton's Discovery of the Laws of Motion Questions

1. What happened during each of these significant years in Newton's life:
   1643: _____
   1661: _____
   1665: _____
   1727: _____
2. What is gravity?
3. Describe the experiments that Newton did. What did they lead him to [illegible]?
4. Describe a situation where you have experienced gravity.

MagiCORE

3rd Grade NGSS 3-PS2-1

ABOUT LEXILE LEVELS

MagiCore Learning, LLC is a certified Lexile® Partner. These texts are officially measured and approved by Lexile and MetaMetrics® to ensure appropriate rigor and differentiation for students.

The Lexile Framework® for Reading measures are scientific, quantitative text levels. When the Lexile of a text is measured, specific, measurable attributes of the text are considered, including, but not limited to, word frequency, sentence length, and text cohesion. These are difficult attributes for humans to evaluate, so a computer measures them.

Common Core State Standards uses Lexile level bands as one measure of text complexity. Text complexity ranges ensure students are college and career ready by the end of 12th grade. Lexile measures help educators scaffold and differentiate instruction as well as monitor reading growth.

Grade Band	Lexile® Bands Aligned to Common Core Expectations
K-1	N/A
2-3	420L-820L
4-5	740L-1010L
6-8	925L-1185L

Keep in mind when using any leveled text that many students will need scaffolding and support to reach text at the high end of their grade band. According to Appendix A of the Common Core Standards, "It is important to recognize that scaffolding often is entirely appropriate. The expectation that scaffolding will occur with particularly challenging texts is built into the Standards' grade-by-grade text complexity expectations, for example. The general movement, however, should be toward decreasing scaffolding and increasing independence both within and across the text complexity bands defined in the Standards."

Balanced and Unbalanced Forces

3rd grade

Table of Contents

Each passage set includes two differentiated passages on a third-grade level (one at the beginning of the band, one towards the end) and a question set geared towards comprehension and science mastery. The first question is differentiated to include a fill-in-the-blank diagram (lower complexity) or an open-ended diagram (higher complexity).

How to Use This Resource

This resource was created with the NGSS Science Standards in mind. It includes seven differentiated passages aligned to the following standard:

3-PS2-1: Balanced and Unbalanced Forces

Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. (Cause and Effect)

Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and balanced forces pushing on a box from both sides will not produce any motion at all.

Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.

Here are some suggestions for using these passages:

- Use as independent work after you have taught an overview of this standard. Assign the different levels based on the passage students can read and comprehend independently.
- Use as a reading center to reinforce key comprehension and science concepts at the same time!
- Use as a homework or review packet.
- Use as an intervention for students who need to revisit science concepts.

480L

Name: _____ Date: _____

Newton's Discovery of the Laws of Motion

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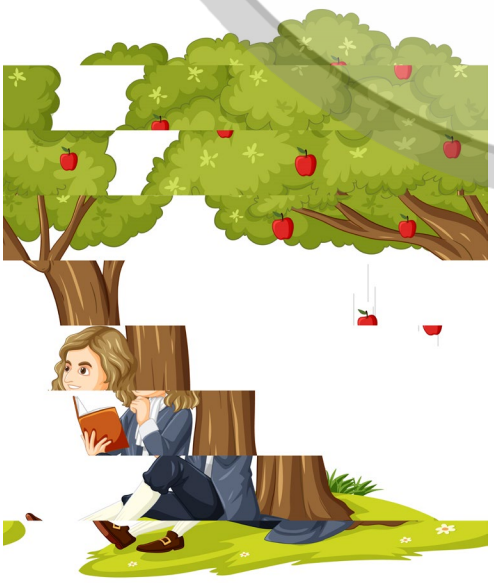
Isaac Newton

How do we know about these ideas? Sir Isaac Newton helped. He was born on January 4, 1643, in England. Newton didn't want to be a farmer like his father. He stayed in school instead. He went to the University of Cambridge's Trinity College in 1661. In 1665, a sickness closed the college. Newton spent time back at his home. He kept learning, though. He made many **theories,** or ideas, about science and mathematics.

Newton spent much time alone. It was said he sat below an apple tree. An apple may have fallen on him. He thought about forces and motion after this. He studied objects. He tested what forces act on them. He learned how those forces affected the objects. Newton's **experiments** led to his understanding of gravity. He used it to describe the movements of the planets and the sun. He developed his three laws of motion in 1666.



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2. What is gravity?

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3. Describe the experiments that Newton did. What did they lead him to understand?

_____

_____

_____

4. Describe a situation where you have experienced gravity.

_____

_____

_____

740L

Name: _____ Date: _____

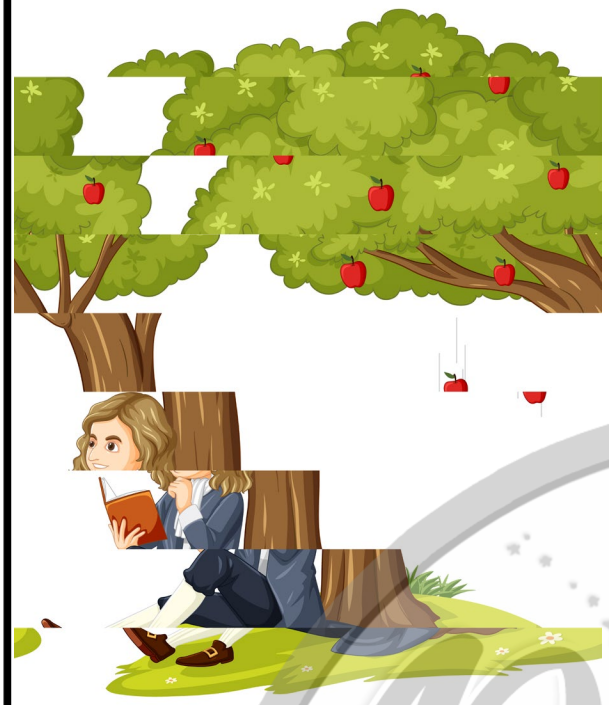
Newton's Discovery of the Laws of Motion

Anyone who has ever dropped something knows about **gravity**. Gravity is an invisible **force** that pulls objects toward each other. Earth's gravity is what makes that fork you dropped at the dinner table clatter to the floor. It's also what keeps you in your seat when you're playing your favorite video game. Do you like baseball? Forces, gravity, and **motion** are all at work on the baseball field, too. Without an understanding of these ideas, life on Earth would be different.

Isaac Newton

A replica of Newton's reflecting telescope he invented.

How do we know about gravity, forces, and motion? One important scientist who helped humans understand these ideas was Sir Isaac Newton. He was born on January 4, 1643, in England. Raised by his grandmother, Newton didn't want to be a farmer as his father had been. He stayed in school instead. He attended the University of Cambridge's Trinity College in 1661. In 1665, a sickness closed the college. Newton spent time back at his home. He kept learning, though. He developed many **theories,** or ideas, about science and mathematics.



It was during this time alone that Newton was said to have been sitting below an apple tree. An apple was said to have fallen on him. This event supposedly caused him to think about forces and motion. Writings have proven that Newton did witness an apple falling. He was then inspired to study objects, what forces act upon them, and how those forces affect the objects. The reports, however, didn't say he was actually hit with the apple. Newton's **experiments** and studies led to him using gravity to describe the movements of the planets and the sun. He developed his three laws of motion in 1666. He was only 23 years old. Newton also invented a type of math called **calculus**. This math is used in engineering and science. The reflecting **telescope** is a tool Newton invented that is still used in astronomy today.

Newton's three laws of motion have been proven by many other scientists over the years. These laws became the basis for **physics**. Physics is the study of matter, motion, and energy. Newton's work has affected other branches of science, too. They have contributed to many different inventions. Humans are able to travel into space due to Newton's three laws of motion. Sir Isaac Newton died on March 31, 1727. His discoveries live on and affect your everyday life.

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_____

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4. Describe a situation where you have experienced gravity.

_____

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_____

500L

Name: _____ Date: _____

Why Do Ships Float?

USS Gerald R. Ford

The USS Gerald R. Ford is a ship. It is part of the United States Navy. The ship is huge. It can hold more than 4,500 people. The USS Gerald R. Ford is an aircraft carrier. This means it has airplanes. It also has a huge runway. It can hold up to 90 airplanes.

You must be thinking, "that's a lot of stuff to put on a boat." And it is. The USS Gerald R. Ford weighs over 90,000 tons. That's about the same as 14,000 African elephants. So how does it float?

Boats have been used for a long time. We didn't always know what made them float. Early boats were made of wood. Have you thrown a stick into a pond? Then you know that wood floats. Wood is less dense than water. It naturally floats. People thought boats float because they are made of wood. But metal is a different story. If you threw a piece of metal into a pond, it would sink. So how did humans figure out how to make metal boats?

They used the law of **balanced forces**. A Greek scientist named Archimedes made an important discovery. He filled his bathtub to the top with water. He stepped in. The water rose and overflowed. He put other objects in water. He noticed that made the water rise. He began measuring the changes in water levels. He measured the level when different objects were placed in the water. He could predict how high the water would rise. The height was equal to the volume of the object in the water. The amount the water rose was different if the object floated. The water didn't rise as high. It only rose by the volume of the portion of the object that was under water.

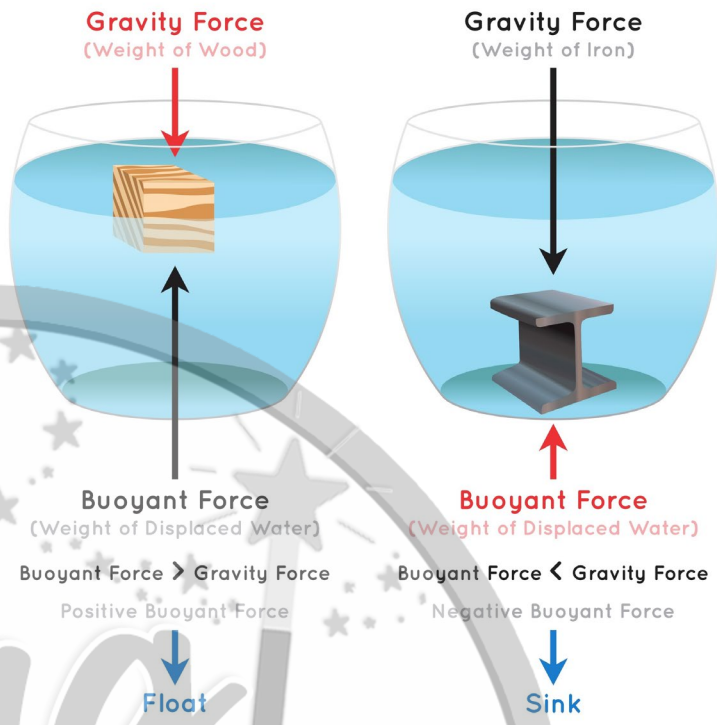

Diagram showing gravity and buoyant force

So how does this help us understand how big boats float? Well, Archimedes made a theory. He said the water pushes upward against floating objects. He called this the **buoyant force**. He measured the **mass** of the water that was displaced by a floating object. This mass was equal to the mass of the object. So, the water pushes back on the object with the exact force that the object pushed down on the water.

We can apply this to the USS Gerald R. Ford. The ship weighs 90,000 tons. So, it's pushing down with 90,000 tons of force. For the ship to float, it must displace at least 90,000 tons of water. If designed correctly, the water will push against the ship. The force of the water pushing up will be equal to the force of the ship pushing down. This creates a **balance** of forces. The force of the ship's weight and the buoyant force must be balanced. This makes the ship float.

Archimedes' Principle shows us heavy objects can float. But only if forces are balanced.

Why Do Ships Float Questions

1. What happens when an object is placed in water?
   a. The water level rises
   b. The water level drops
   c. The water level does not change
   d. The water level sometimes rises and sometimes drops

2. Describe the "buoyant force". How does it make things float?

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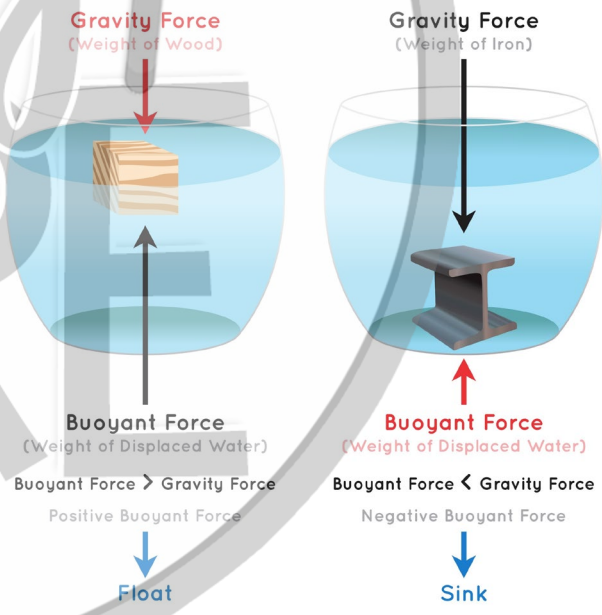
3. Refer to the diagram. What happens when the buoyant force is less than the force of gravity?



4. How do balanced forces explain how a ship as heavy as the USS Gerald R. Ford floats?

820L

Name: _____ Date: _____

The Magic Golf Ball

Have you ever played golf? If so, then you know it's hard to hit a golf ball perfectly straight. Professional golfers try to intentionally curve golf balls to help them navigate winding golf courses. By curving the golf ball, they can hit around trees or other obstacles. They can also make sure the ball rolls toward the hole when it lands. For beginner golfers, the situation is much different. Golf balls can curve out of control on the slightest mishit. It can be hard to keep curving golf balls on the golf course altogether. But what causes golf balls to curve as they travel through the air? Is it magic? Or something a little more scientific?

Golf club and golf ball

The golf ball will continue flying in a straight line until a force acts on it.

The answer isn't as complicated as you may think. To find out why this happens, we need to look no further than Sir Isaac Newton. Newton's First Law of Motion, or the Law of Inertia, states that "every object will remain at rest or in uniform motion in a straight line unless compelled to change by an external **force**." So, what external forces cause a golf ball to change direction mid-flight?

Backspin pushes air from above the ball, under it

Backspin pushes air from under the ball upwards.

When a golfer hits a golf ball, the golf club transfers force to the ball. This force makes it soar through the air. The force of the golf club also makes the ball spin very fast. The direction the ball spins depends on how it was hit. A ball will spin backward in a straight line if it is struck "square." "Square" means the front of the club is directly perpendicular to the direction the club is traveling. However, when the golf club strikes the ball at an angle, the ball will spin sideways.

When a golf ball spins, it creates **unbalanced** forces. The spinning creates pressure changes around the ball. The changes in air pressure change the motion of the ball. Golfers try to get their balls to spin backward. The backward spin helps the ball stay in the air. Gravity will pull the flying golf ball toward the ground. A ball spinning backward pushes air from above it to underneath it. This increases the air pressure under the ball. It decreases the air pressure above the ball. The unbalanced forces push upward on the ball and help it stay in the air longer. The force of gravity will always win and eventually pull the ball back to Earth. When a ball spins backward but not sideways, the air on each side of the ball is not affected. So, the force created by the air on each side of the ball is **balanced**. This makes the ball travel in a straight line. Of course, that's as long as another force like the wind doesn't affect it.

When golfers hit the ball at an angle, the ball spins sideways. Even a small angle can make a golf ball spin rapidly. A sideways spinning ball pushes air from one side to another. This creates unbalanced forces. Unbalanced forces will cause the direction of an object to change. These forces will move the ball sideways. If a ball is spinning toward the left, it will move air away from the right side of the ball and toward the left side. With higher pressure on the left side than the right, the ball will begin to curve to the right. If a ball is spinning toward the right, it will hook to the left for the same reason.

Professional golfers are very precise. They can use these simple scientific principles to their advantage. Sometimes they want to curve the ball left. So, they hit the ball with the club angled slightly left. Novice golfers, on the other hand, are not very precise. They have trouble keeping their club straight when they hit the ball. This creates spinning golf balls. That can make it hard for them to hit the ball where they want it to go.

If you're ever out hitting golf balls or watching golf on TV, you can experience these unbalanced forces for yourself. It's not magic! Just a bit of science.

The Magic Golf Ball Questions

1. It can be hard to hit a golf ball straight. Why?
    a. Golf balls are very small
    b. Golf balls spin easily
    c. Golf balls have dimples
    d. Golf is played on grass courses

2. What happens when a golf ball spins backwards but not to either side? Why?

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3. Draw arrows and label them to show the direction of the forces acting on a golf ball that is hooking left.

4. How does Newton's First Law of Motion help us understand what happens when golf balls curve in the air?

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