MOTION AND SIMPLE MACHINES

Grades 7-8

STUDENT JOURNAL

This journal belongs to:

THE GOOD AND THE BEAUTIFUL

Motion and Simple Machines

LEVEL 7-8 STUDENT JOURNAL

The Good and the Beautiful
CURRICULUM

INSTRUCTIONS

This student journal accompanies *The Good and the Beautiful Motion and Simple Machines* science unit. It contains all the worksheets and journal pages that are needed to complete the unit. Each student will need his or her own copy of the science journal.

The Motion and Simple Machines lesson extensions are also found here. These extensions are optional for older students (grades 7–8) to complete on their own. Each extension is accompanied by lined paper so the student can keep his or her work in one place.

Have each student take his or her time to create high-quality work as the activities and worksheets are completed. Students may enjoy looking back on their past discoveries when they've finished.

TABLE OF CONTENTS

Isaac Newton

Directions: Read the quotes by Isaac Newton on the "Isaac Newton Quotes" page. Pick your favorite one and copy it in the space provided below.

Three inspiring things about Isaac Newton:

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2

3

Isaac Newton Quotes

"If I have seen further it is because I have stood on the shoulders of giants."

"I believe the more I study science, the more I believe in God."

"Genius is patience."

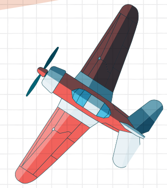
"He who thinks half-heartedly will not believe in God; but he who really thinks has to believe in God."

"It is the perfection of God's works that they are all done with the greatest simplicity. He is the God of order and not of confusion."

EXTENSION

Instructions:

1. Read the information below.
2. Define and describe the difference between scalar and vector quantities in your science journal.
3. Look at the images of different vector and scalar quantities and match each one to the correct description.



Vector and Scalar Quantities

Measuring is an important part of a scientist's job. When physicists measure motion and the movement of objects, there are several factors that they must consider. Physicists measure the movement of objects as either a ***scalar quantity*** or a ***vector quantity***.

Scalar Quantities

Scalar quantities consist of measurements that only include a numerical size (numbers that measure length, size, or an amount of something). Scientists call these types of measurements ***magnitude***. So anything that can be measured with numbers has a magnitude. Examples of scalar quantities include measurements of mass, volume, distance, time, speed, temperature, energy, etc. All these things can be measured with numbers. For example, when a pilot measures the time it takes to travel from one destination to another, he or she records that measurement as a magnitude because it is a number.

Vector Quantities

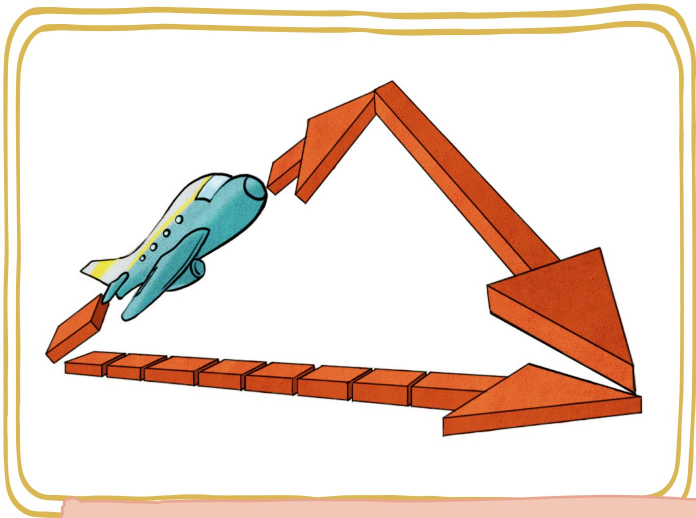
Vector quantities have both magnitude and direction. Velocity is a vector quantity because it measures both speed and direction. For pilots to be able to reach their destination, they are going to need to know more than just how long to fly the plane. They will also need to know which direction to go and how fast to accelerate at different stages of the trip so that they can fly the plane safely and effectively to the correct destination.

Velocity is not the only type of vector quantity. Other things that can be measured as vectors are force, momentum, acceleration, magnetic fields, currents, etc.

Vectors are also used to measure ***displacement.*** Displacement is when something is moved from one place to another. If you are standing in line at the grocery store, and someone offers for you to move ahead of them in line, then as you move forward one spot, you are experiencing displacement. You can measure this as a number (one spot, or the actual distance may also be measured), and you can measure this as a direction (forward, or toward the cashier). The important thing about displacement is that it is about the difference between the starting and ending spots, not about the total distance traveled. For example, if you were to run exactly one lap on a circular track, then there would be no displacement because you started and ended in the same place.

For you to have displacement, you would have to arrive somewhere different from where you started.

Vectors are often represented on graphs as lines with pointed arrows to show the direction of the object. Many times there are multiple vectors that need to be considered. Let's say a pilot is navigating through strong headwinds. The pilot needs to understand how velocity vectors work in order to adjust the speed of the aircraft to stay on course. Ground speed (the speed relative to the ground) and airspeed (the true speed at which the plane is traveling in its own power with respect to the air) may vary depending on the wind's effect on the plane. The pilot can adjust the velocity (speed and angle/direction) of the plane accordingly in order to stay on course.



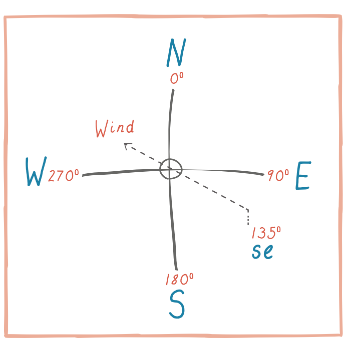
Example of an alternate course a pilot may take during strong headwinds to stay on course

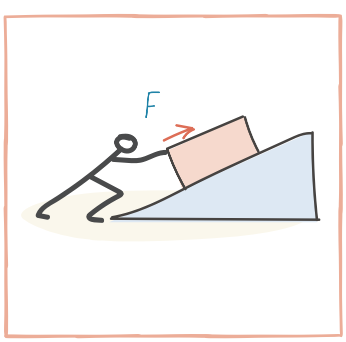
Conversely, if an airplane is experiencing tailwinds (wind coming from behind), those winds will push on the plane in a forward direction with more force, causing the plane's velocity to increase. These vectors can be added together on a graph to show the outcome of external (outside) forces on an object. In these scenarios the shape created on a graph often looks like a triangle.

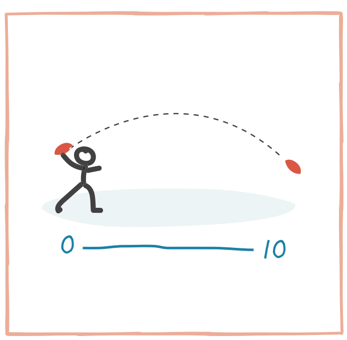
You can see that understanding vectors is crucial for pilots, but transportation is not the only place vectors are used. Astronauts, doctors, meteorologists, engineers, sea captains, and scientists of all kinds use scalar and vector quantities.

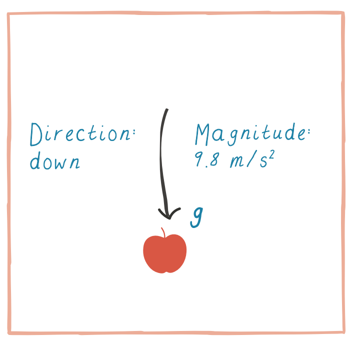
Look at the various examples of vector and scalar quantities in the circles below. Cross out the scalar quantities. In the circles that describe vector quantities, circle the magnitude and underline the direction in each example. Remember, a vector has to have both! Then match the vector quantities to the box that best represents each description.

- Wind speeds of 20 knots blowing NW
- A car going 70 miles per hour
- A football is thrown and caught (displaced) 10 yards down the field
- An apple falling from a tree at the acceleration of 9.8 (m/s^2)
- Pushing a box with a force of 40 Newtons to the right
- Waking up at 7:15









Gravity

DROPPING DIFFERENT BALLS EXPERIMENT

My hypothesis:

The outcome:

Gravity is a ________ of attraction between ______ masses.

EXTENSION

Instructions:

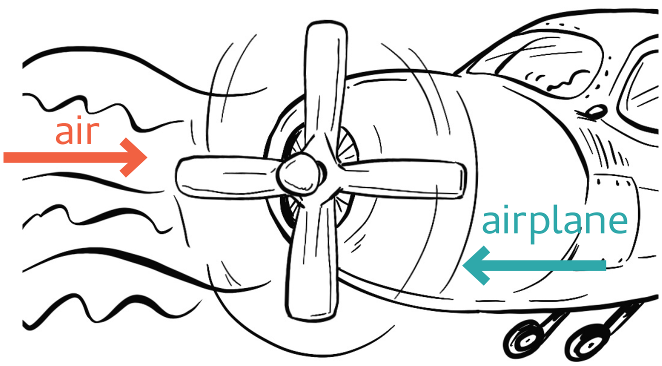
1. Read the information below.
2. In your science journal, draw a diagram of how each of the following works: an airplane, a rocket, and a jet. Be sure to include Newton's Third Law of Motion.

Airplanes, Rockets, and Jets, Oh My!

Newton's Third Law is what makes it possible to fly airplanes and launch rockets. Remember that Newton's Third Law states that when an object pushes toward another object, the object being acted upon pushes back with equal force. We are going to see how this applies to flight!

Airplanes

Think of an airplane propeller on the front of a plane. Propellers are designed with a curved shape that pushes air back *toward* the body of the plane when they spin. At first, you might think it would be counterproductive to cause air to push back on a plane that you want to move forward. But according to Newton's Third Law, what will happen if air is pushed toward the body of the plane?

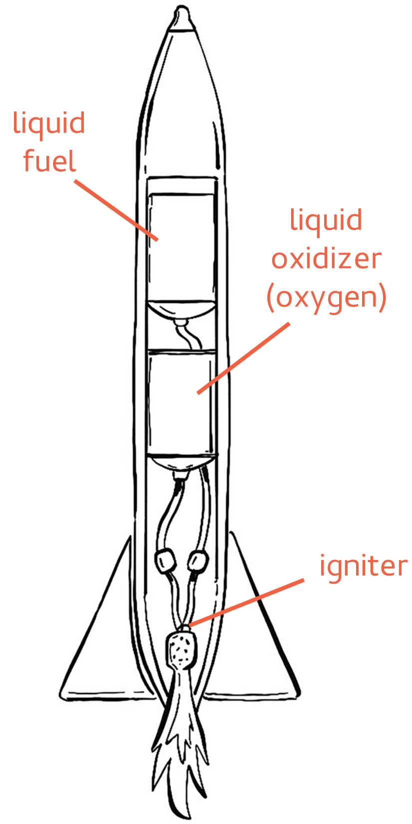


The air behind the propeller will push back! So it actually pushes the plane forward.

This works wonderfully for planes flying within our atmosphere, but the farther you get from Earth's surface, the fewer air molecules there are. By the time you get to space, there are no air molecules at all. So that's why if you want to get to space, you can't do it in an airplane.

Rockets

Rockets are designed completely differently from airplanes, although they still use Newton's Third Law to reach great heights. Since rockets cannot rely on outside forces to help propel them, they carry propellants within the rocket. Propellants are a blend of fuels that explode when mixed with oxygen and ignited. This explosion creates gases that exit through the bottom of the rocket. This allows Newton's Third Law to propel the rocket forward as the gases push out the back.



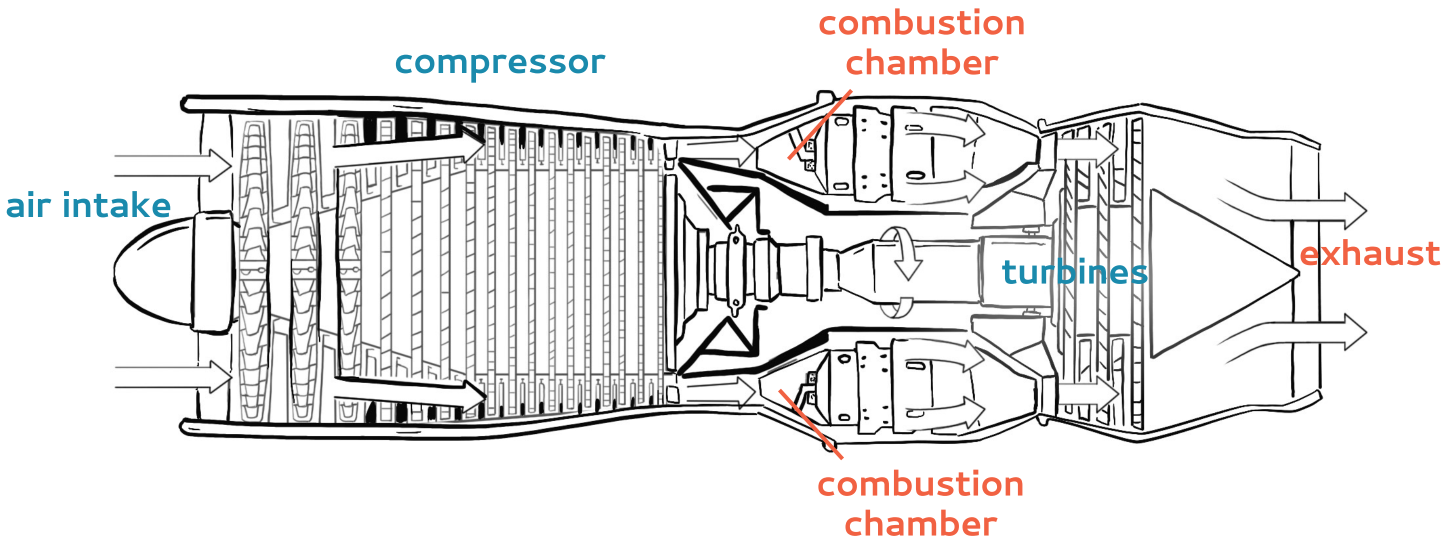
Jets

Now, jets are built differently from both propeller planes and rockets. Scientists take a piece of both designs and are able to create airplanes that can fly at very fast speeds.

Jets have fans located near the back of the plane or along the wings that pull air into the plane engine, just like a propeller does. This does provide some thrust, but the rest of the air goes through a compressor which squeezes the air, giving it a higher pressure. This compressed air is then pushed into the ***combustion*** chamber**.** Combustion is the process of burning something. This chamber is where the fuel is stored, and when the compressed air mixes with the fuel, it ignites the fuel, which explodes the same way a rocket engine does (but at a smaller scale). Jets also have a second set of fans installed at the back of the plane called turbines. When the explosive air passes through these fans, the fans are able to use the power they create by spinning to send power back up to the compressor to keep it running.

Now and Then

Isn't it incredible that Newton was able to develop these laws of motion hundreds of years ago by observing how things around him worked? And now we are able to use these laws to create machines that can transport us across the world in hours and send astronauts into space! You never know what kind of influence you will have for generations to come.



"Native American Bow Hunting"
by Hamilton Irving Marlatt (1867–1929), 1915

EXTENSION

Instructions:

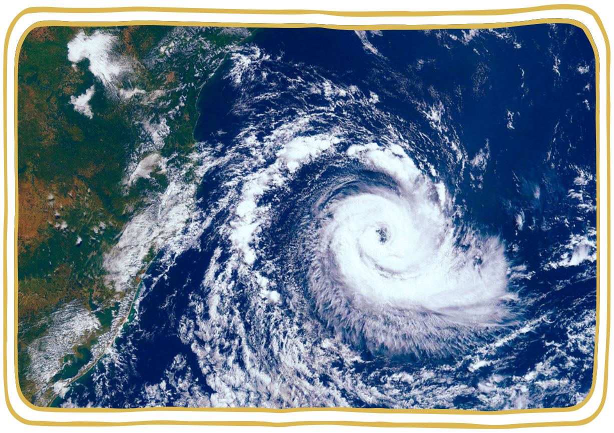
1. Read the information below.
2. Complete the experiment listed on the next page. Then record your observations in the space provided.

Coriolis Effect

Do you remember Newton's First Law? An object at rest will stay at rest, or an object in motion will stay in motion as it moves in a straight path until it is acted upon by another force. While this is true, there are situations that affect the appearance of this straight path.

Coriolis Effect

The ***Coriolis effect*** is a phenomenon of rotating spheres, like Earth, where objects above the sphere are displaced by the rotation of the sphere. In other words, since the sphere is rotating, even an object moving straight will not arrive at a point straight ahead because the rotating sphere beneath it moved!



Motion is the change in location of an object, and it is relative, meaning it is understood and measured from a frame of reference or point of view. In our case the reference point we observe from is on Earth. What we perceive can appear differently depending on exactly where we are on Earth.

The earth is slowly rotating, or spinning, on an invisible axis in an eastward motion, but that motion looks different depending on the hemisphere you are in. If you were looking at Earth from the North Pole, the rotation would appear counterclockwise. If you were looking at Earth's rotation from the South Pole, the rotation would appear clockwise. An object moving straight ahead freely for a long distance will curve right in the Northern Hemisphere and curve left in the Southern Hemisphere. This is due to the Coriolis effect.

Hurricanes

Let's think for a moment about a hurricane. The Coriolis effect plays an important role in the formation of hurricanes. Air moves toward areas of low pressure in all directions. As large masses of air move straight toward an area of low pressure, the earth beneath it still continues to spin, so the air curves right or left depending on the hemisphere it is in. This curving motion creates a cyclone, and if the air speeds become fast enough, a hurricane is formed.

Although the Coriolis effect isn't noticeable in movements over small distances, like throwing a paper airplane across your yard, it does show up in the movements of objects over more significant distances or at high speeds. Airplanes, rockets, and large masses of air are all examples of objects in motion that can be affected by the Coriolis effect.

Other Planets

Earth is not the only place the Coriolis effect takes place. It happens wherever there is spinning motion, so all planets experience this phenomenon. The other planets actually spin much more quickly than Earth does, so the Coriolis effect is more noticeable on these celestial bodies. Jupiter has the fastest rotation of all the planets in our solar system. It completes a full rotation in just under 10 hours. This rapid motion changes the direction of the winds that are blowing faster than 380 miles per hour (611.551 kilometers per hour). This type of movement creates storms so big that we can see them from space. Jupiter's Great Red Spot is the largest and most famous storm. Now, whenever you see an image of Jupiter or think about the weather or an approaching storm, you will know that it is all influenced by the Coriolis effect.

CORIOLIS EFFECT EXPERIMENT

Step 1: Cut a piece of paper into the shape of a circle and set it in front of you on the table.

Step 2: Place a ruler across the center of the paper and tape both ends of the ruler to the table.

Step 3: Place one hand on the paper circle and begin to spin it counterclockwise. As you do so, take a pencil and draw a line with your pencil up against the ruler. What do you think will happen? Write your hypothesis in the space provided at the bottom of the page.

Step 4: This exercise shows how the Coriolis effect affects the Northern Hemisphere. Under the heading "What Happened?" explain how even though you were moving your pencil forward in a straight line, it looked like it was curving because the paper was spinning.

Step 5: Repeat the activity, turning the piece of paper clockwise. Again, record what happened and take note that this relates to the Coriolis effect in the Southern Hemisphere.

Step 6: Repeat this activity on another sheet of paper. This time turn the paper more quickly.

You can see that the faster you spin the paper, the more curvy your line is!

Hypothesis:

What happened?

SIMPLE MACHINES

Draw a way to make it easier to move a sofa with simple machines.

EXTENSION

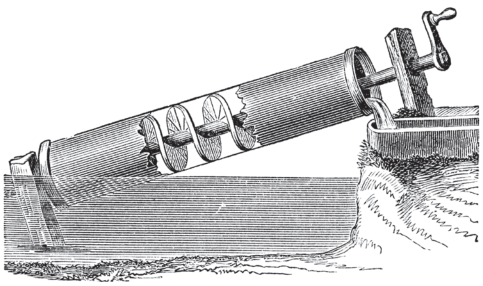
Instructions:

1. Read the information below.
2. Draw and label the three main components of an Archimedes screw in your science journal.
3. With permission from your parent or teacher, research a current use of the Archimedes screw. Write a 5—8-sentence paragraph in your science journal describing how it is used.

The Archimedes Screw

Screws are most commonly used to hold things together. We have also learned that they can be used to lift heavy objects, but do you think a screw could lift or push water? Well, a brilliant inventor and mathematician born in Sicily in 287 BC thought so. We know that moving water, especially from a lower elevation to a higher one, presents a difficult dilemma. Archimedes developed a screw of mammoth proportions to move water from a lower elevation to a higher one; it is known as the Archimedes screw.

Archimedes' screw is made up of three main components: a screw, a hollow pipe, and a crank. The screw fits inside the hollow pipe, which is set at an angle in the water. The screw is turned by the crank, and then water is pulled from the bottom of the screw sitting in the water to the top end. Therefore, the screw effectively lifts the water to a new location above the water source. The crank can be turned by hand, windmill, livestock, or (in modern times) a motor.



Ancient Uses of the Archimedes Screw

In ancient times the screw was primarily used to irrigate fields and pump water. Instead of electric power, the pump was powered by oxen or people. Used in the Nile River for centuries, the Archimedes screw allowed farmers to efficiently irrigate their crops.

Historians believe the Archimedes screw also could have been used to irrigate the Hanging Gardens of Babylon, which is one of the Seven Wonders of the Ancient World.

Modern Uses of the Archimedes Screw

In 2001 this versatile invention was used to stabilize the Leaning Tower of Pisa. In this case the screw was not used to move water but to lift soil. By removing small amounts of soil saturated by groundwater, the weight of the tower corrected the lean.

At the famous Windsor Castle in England, an Archimedes screw functions as a generator providing power to the castle.

SeaWorld Adventure Park in San Diego, California, employs two Archimedes screws to lift water for the Shipwreck Rapids ride.

In a partnership between the US Department of Energy and the Utah Water Research Lab at Utah State University, new energy-saving methods are being discovered for water-powered screws used to produce electric power.

A machine called the Hemopump has been developed to assist heart surgeons. This machine uses a tiny Archimedes screw, the diameter of a pencil eraser, to keep blood pumping during heart surgery.

Archimedes never knew that his invention to haul water would be used in so many incredible ways. Maybe something you do will one day affect many people in ways you will never know!

COMPLEX MACHINES

Write down examples of complex machines. Pick one to draw in the orange box, and then label the simple machines it is made with.