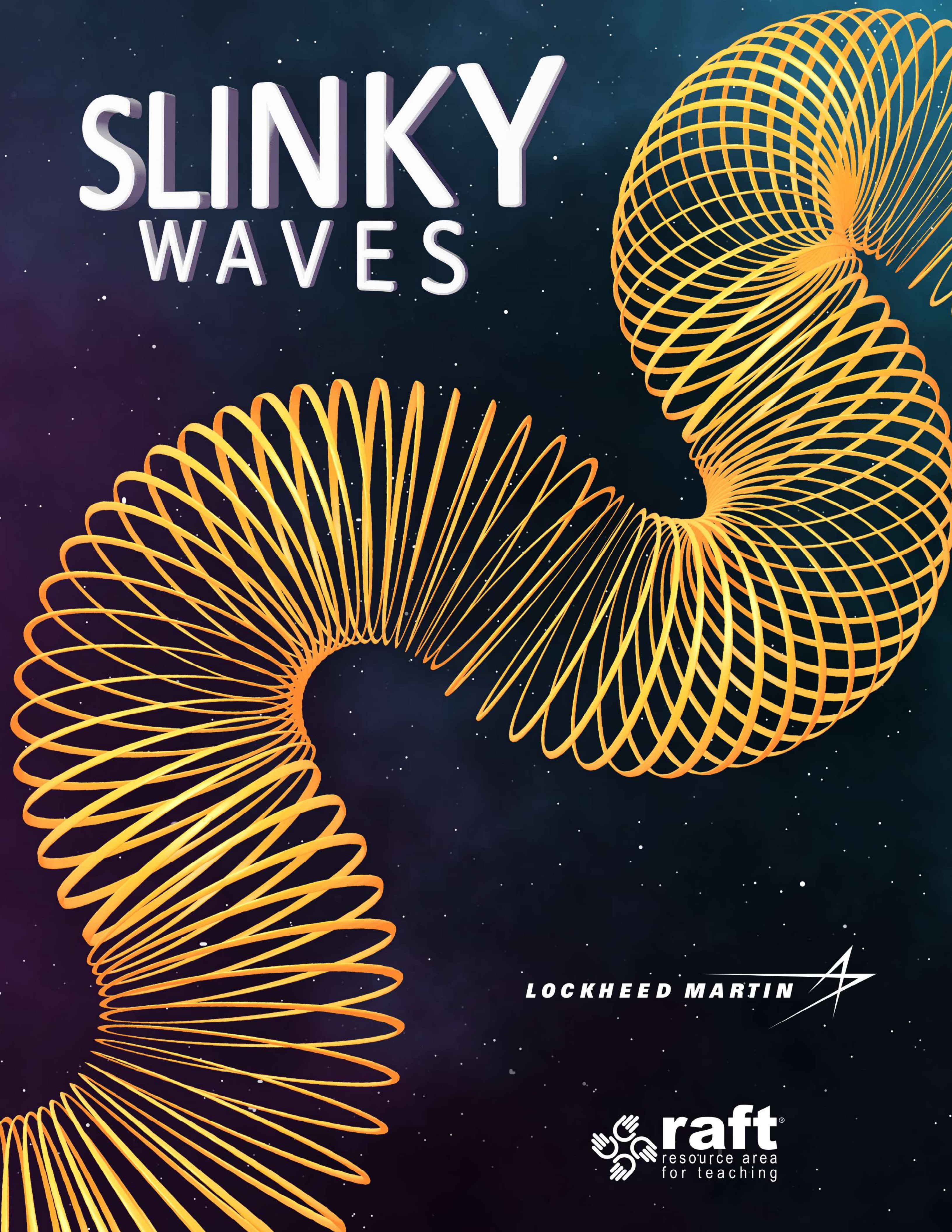
SLINKY WAVES



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Waves are all around us – some visible, some invisible. A simple slinky is a great tool to learn about waves and energy.

To Do and Notice:

1. Have students work in groups of 3-4. They will need to have room to stretch the slinky out onto a large smooth surface – tables and floors work well. (They could do this experiment standing up, but it is more difficult to observe)
2. Let them play with the slinky for a bit and see how it behaves.
3. Then, give the students a little structure. Ask each student to hold an end of the slinky and do some experiments and note what happens.

Compression Waves

1. Have one student pinch a few of the coils of the slinky together and then release them. Note what happens. [compression wave]
2. Have the student pinch more and more coils and note what happens.

Transverse Waves

1. Have one student wiggle the slinky side to side one time. Note what happens. Wiggle it again several times. Note what happens.
2. Have the students try to wiggle it so that there is only one point in the slinky that moves up and down. [Standing point]
3. Have them wiggle it so that there are two spots that just move up and down.
4. How many places can they make move up and down? Have the students report out what they had to do to make more spots that moved this way.

Mods

1. Have the students move closer to each other and repeat the experiments.
2. Have the students move farther away from each other and repeat the experiments.
3. Put paper on the floor or table, then have the students repeat the experiments on top of the paper, working in teams to mark the peaks and troughs, then fill in the wave pattern, then measure wavelengths and amplitude.

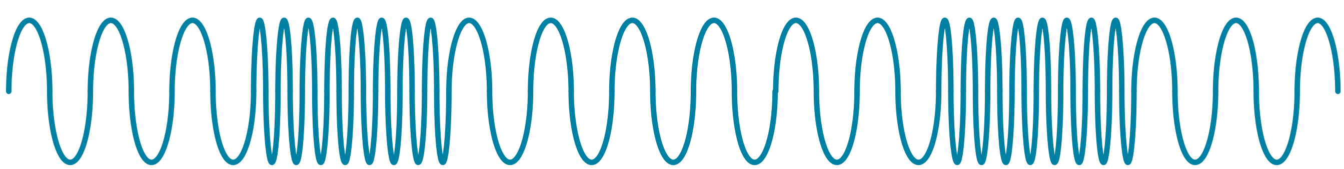
The Science Behind the Activity:

Mechanical and Electromagnetic Waves:
One way to categorize waves is whether or not they need a medium to travel through. The terms for this categorization are Mechanical Waves and Electromagnetic Waves.

Mechanical waves (sound waves, jump rope waves and water waves) need a medium (solid, liquid, or gas) to travel through. Electromagnetic waves do not need a medium to travel through; they can transmit energy through a vacuum. Electromagnetic waves are unique transverse waves (see below) and include the light we can see, microwaves, radio waves, and infrared waves. Satellites communicate through radio waves.

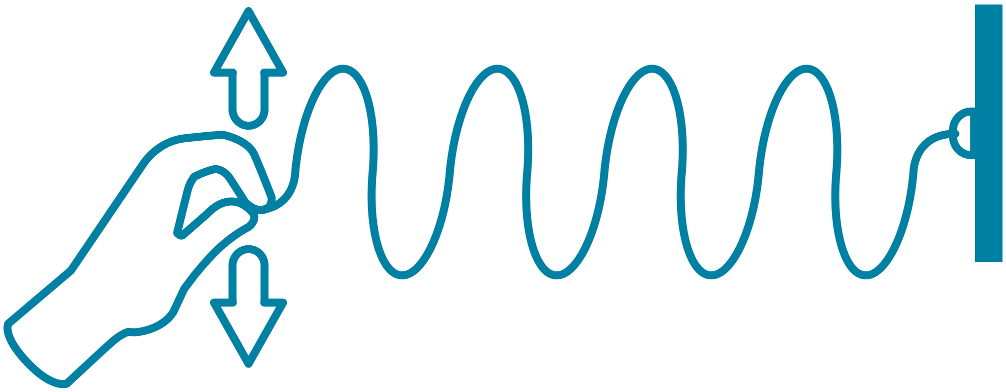
In this activity, we observe mechanical waves. The medium the energy moves through is a slinky. No matter what the medium is, waves move energy but not the medium.

Compression (Longitudinal) and Transverse Waves:
Another way to classify waves is by the way they travel. The terms for this categorization are compression waves (also known as longitudinal waves) and transverse waves. In this activity, students create and observe both kinds of waves.



Compression (Longitudinal) Waves:
When the slinky is pulled apart between the two students it is at rest. Pinching a few of the coils together requires energy. That energy is stored in the coils of the slinky that are compressed together. By letting go of (decompressing) the coils, the energy is released. By pinching more coils together, students can visualize the effects of more stored energy.

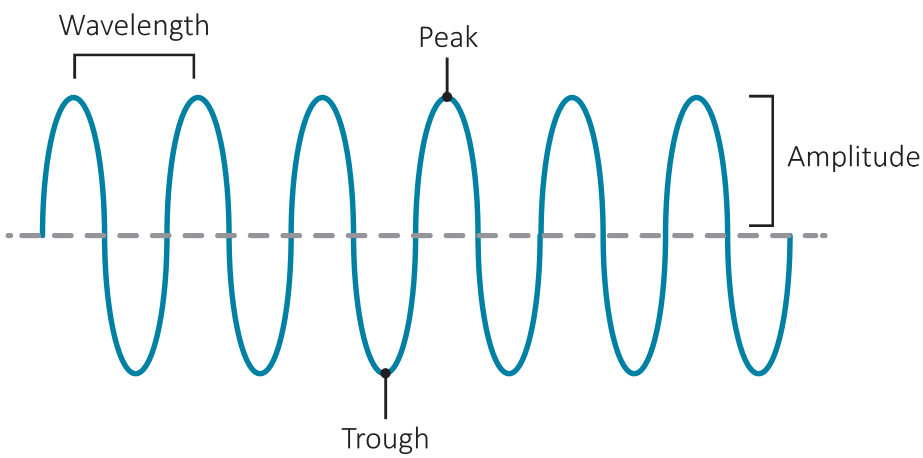
The energy propagates, or moves, through the medium from where it was released to the end of the medium. With the slinky, it is easy to visualize the energy as it propagates, it is the smooshing and relaxing of the coils as it moves from one end to the other. When this movement occurs in air, for example, when we listen to the radio or a friend calling to us across the street, we hear the wave as sound. Compression waves are always mechanical waves.



Transverse Waves:
Transverse waves are made by wiggling the slinky up and down or side to side. The movement, or wiggling, of the slinky is at a 90 degree angle to the direction the wave moves, which is why it is called a transverse wave. As the energy propagates through the medium it looks like a mountain and valley moving from one end of the slinky to the other and back. When the slinky is wiggled several times, there are several mountains and valleys, or waves, that move through the medium. The wave length is easy to see. It is the distance between the tops of two mountains

A standing wave is a special type of transverse wave, where the length of the medium (here, the slinky) and the length of the wave(s) match up so that when the energy reflects (bounces back) into the medium it causes the peaks and troughs (high places and low places) to appear to not move down the length of the medium but stand still. Transverse waves may be either mechanical or electromagnetic waves.

Measuring Waves:
Frequency refers to the number of waves that occur between the start and end point of the medium.
Wavelength refers to the distance between the peaks (crests) or troughs of a wave.
The higher the frequency, the shorter the wavelength. With sound, higher frequency translates to a higher pitch.



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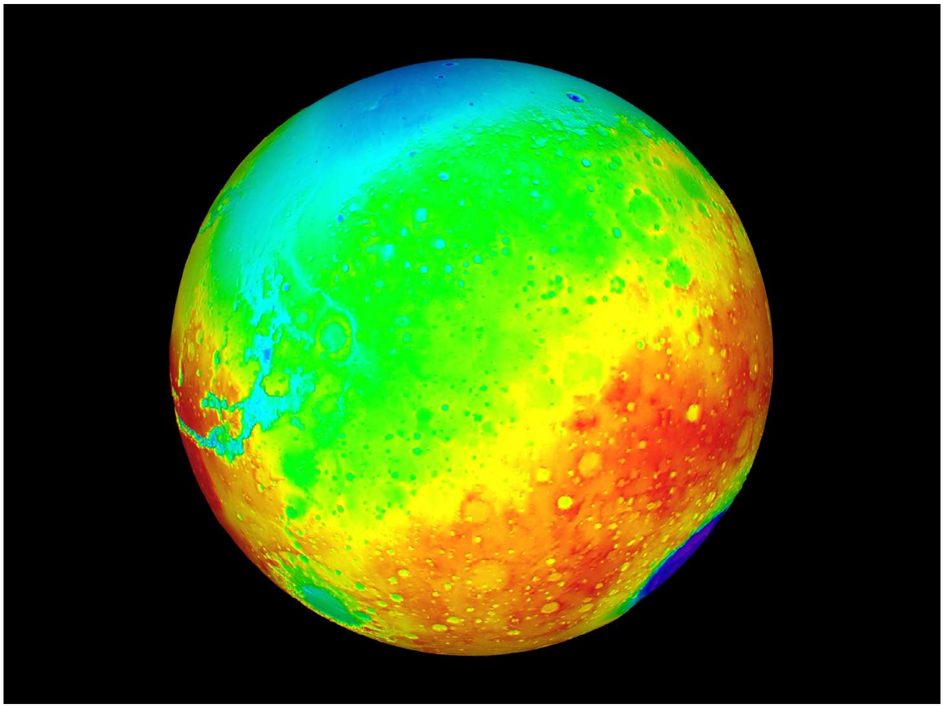
Applications in Space:
We use remote sensing to learn about space. Remote sensing is the process of studying information received from different kinds of waves including radio for communication, and light waves for images of bodies in space.

As humans, we only have the physical capacity to see and hear certain categories of waves, so we use tools to enhance our perceptions. For example, infrared light reveals information about planets that we can't see with our eyes, even while using telescopes.

Here is an image of Mars taken with an infrared filter:



Take It Further:
- Try the experiment with different mediums, e.g., cords, jump ropes, chains. How does the medium affect the wavelengths?

Classroom Resources:

Introductory information about waves: http://www.physicsclassroom.com/mmedia/waves/lw.cfm

Acoustics and Vibration Animations from Daniel A. Russell, Graduate Program in Acoustics, The Pennsylvania State University: https://www.acs.psu.edu/drussell/demos/waves/wavemotion.html

The Doppler Effect is used by astronomers to learn more about stars and galaxies:
http://www.physicsclassroom.com/class/waves/Lesson-3/The-Doppler-Effect

Lockheed Martin engineers think about waves every day as they build spacecraft.
Learn more at lockheedmartin.com/space.

This RAFT kit was developed in partnership with the following Lockheed Martin engineers:

Chris Homolac

Mechanical Engineer for the Orion Human Spaceflight Program

Chris had an engineering epiphany as a child when he received a package that wasn't filled with wasteful packaging peanuts but instead with little pieces of recyclable cardboard bent into small triangular shapes. This has forever changed the way he thinks about how everything is made and how it can be less wasteful. It also helped fuel Chris' passion for building, tinkering and creating things.

Today, as a manufacturing engineer, Chris supports the production of a number of crew systems assemblies for the Orion human spaceflight capsule.

Eileen Liu

Software Engineer for the Lunar Orbiting Platform-Gateway

While Eileen was growing up, she and her brother would gather LEGOs and all kinds of scrap things around the house, and then, armed with a tool box and soldering iron, use their creativity to imagine and build everything under the sun.

These days, Eileen is working on design concepts for NASA's Gateway – a space station that will orbit the Moon and will help humans return to the Moon and prepare to someday visit Mars and beyond.

Ben Mihevc

Guidance Navigation and Control Engineer for the Mars Reconnaissance Orbiter

Ben made model rockets with his dad growing up. The cardboard rockets often didn't work and figuring out why things exploded when they should not have and didn't explode when they should have was part of what led him to engineering.

Ben now uses his degrees in Computer Engineering to figure out where the orbiter is, what it is doing, and how to make sure it moves to where it needs to be safely.

Wil Santiago

Mechanical Engineer for Deep Space Exploration

Some of Wil's earliest memories are of playing in his mom's yard, uprooting the grass to make airports for his toy airplanes. Toy airplanes led to an interest in rockets and spacecraft, and he knew he wanted to do work in space exploration.

Wil's job is to design and fly spacecraft in deep space around places like Mars and Jupiter; helping to ensure that all spacecraft temperatures are at optimal levels in the extreme environment of space.

Liam Smith

Research & Development Scientist

Liam grew up by the beach and discovered sea glass while he was surfing. He filled his pockets and loved how looking through the glass lens changed how the world looked. From there, he started taking apart his mom's cameras to look at the world through those lenses. As a professional photographer, she was less than thrilled with this development, so she got him a telescope. He looked into space, and never stopped.

These days, Liam focuses on space situational awareness, which means understanding and tracking where satellites are in space at all times. He specializes in earth satellites that use this awareness to perform traffic control in space.

Morgan Yost

Software Engineer for the Orion Human Spaceflight Program

When Morgan was young, she wanted to be a grocery store clerk. She and her sister had a toy scanning machine, and she loved the bright beep noise the scanner made (sound waves!) as they swiped the food across, and she was also good at adding up all of the numbers.

With her work on the Orion mission, Morgan is a Software Engineer on the guidance (where the spacecraft is going), navigation (calculating where the spacecraft is), and control (how to get it to Mars) team. She uses math every day to make sure the spacecraft can get humans to the Moon and Mars!