



# String Can Telephone

AGES 5-ADULT


## OBJECTIVE


With this activity, students will learn how a message can be sent and received. In addition, students will learn modulation by observing sound moving as a wave from one cup, over the string, to the next up.


Like waves on a pond, a radio wave is a series of repeating peaks and valleys. The entire pattern of a wave, before it repeats itself, is called a cycle. The wavelength is the distance a wave takes to complete one cycle.


In space communications, a radio wave is generated by a transmitter and then detected by a receiver. An antenna allows a radio transmitter to send energy into space and a receiver to pick up energy from space. Transmitters and receivers are typically designed to operate over a limited range of frequencies.

## WHAT YOU'LL NEED

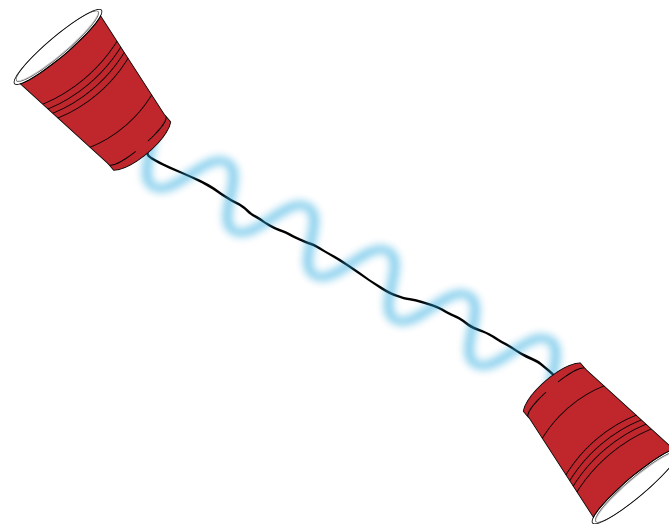
Two plastic cups 

One push pin 

A piece of string 

Two paper clips 

*You can experiment with materials as an engineering project to assess which materials are best.*



## BUILDING PROCEDURE

- 1) Use the push pin to make a hole in the bottom of each cup.
- 2) Insert one end of the string through one of the pin holes.
- 3) Tie a knot around one of the paper clips on the inside of the cup so that the string stays attached to the can. Repeat with the other cup, paper clip and the other end of string. The cups should now be connected to each other.
- 4) Hold one cup, and give the other cup to someone else. Walk away from each other until the string between the cups is tight. Speak into the open end of one cup while your partner listens to the open end of their cup. Change roles and be the listener.
- 5) Send critical messages to each other. Try giving specific actions and see if the receiver performs those actions.

Pretend you are a satellite and a ground antenna sending NASA messages and data back and forth. What does that sound like? What are all the various types of messages that you can communicate?



# Frequency Board

AGES 8-ADULT


## OBJECTIVE

With this activity, students explore the electromagnetic spectrum by creating a frequency board. Students will understand wavelengths and phases by comparing radio and infrared waves. Students will guess the length of string it will take to create waves covering the entire board for each.

The basic building block of radio communications is a radio wave. Like waves on a pond, a radio wave is a series of repeating peaks and valleys. The entire pattern of a wave, before it repeats itself, is called a cycle. The wavelength is the distance a wave takes to complete one cycle. The number of cycles, or times that a wave repeats in a second, is called frequency.

Radio waves range in length from very big like the size of a tall building to small like the size of a coin. Wavelengths that NASA currently communicates with are between the size of a building and the size of a pinhead. NASA uses both radio and infrared waves to communicate.

## WHAT YOU'LL NEED

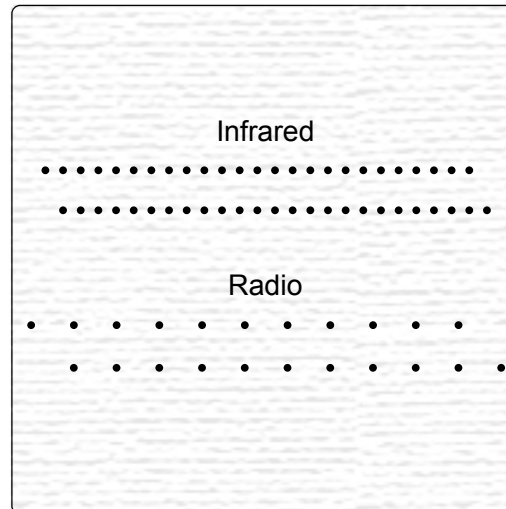
One 12"x12" wooden board 

Around 70 1" nails 

One hammer 

Yarn 

Marker 



## BUILDING PROCEDURE

**\*\*Adult Supervision Required\*\***

### Infrared Frequency:

- 1) Draw two parallel lines two inches apart.
- 2) For the top parallel line, draw around 25 dots that are approximately one centimeter apart.
- 3) For the bottom parallel line, starting a centimeter away from the first dot on the top parallel line, draw around 25 dots that are approximately one centimeter apart.
- 4) Hammer in the nails where you marked the dots. Make sure the nails are secure.

### Radio Frequency:

- 1) Draw two parallel lines two inches apart.
- 2) For the top parallel line, starting as close to the right edge as possible, draw around 11 dots that are approximately one inch apart.
- 3) For the bottom parallel line, starting an inch away from the first dot on the top parallel line, draw around 11 dots that are approximately one inch apart.
- 4) Hammer in the nails where you marked the dots. Make sure the nails are secure.

**\*\*See image to the left for example.\*\***



# Engineering Challenge



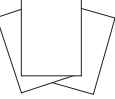

**AGE 8-ADULT**

## OBJECTIVE

With this activity, students become engineers! Engineers are people who design and build things that we use every day. Most of the time, engineers start with a question that needs to be answered. Then, they will start solving the problem in the question by brainstorming a bunch of ideas. Some of the ideas may be simple, and some may be crazy, but it is good to have a lot of different ideas. After coming up with ideas, engineers will pick a few that make the most sense in order to start drawing a plan. After drawing a plan, an engineering can now create something! Once the plan is built, it will have to be tested to see what works and what does not. Sometimes after testing, the plan will need to be modified.

Students will learn the engineering process by working on a team to build an antenna or satellite with a limited amount of supplies. Students will learn team work by collaborating to accomplish the challenge.

## WHAT YOU'LL NEED

- Mini Marshmallows 
- Tooth picks or raw spaghetti 
- Paper 
- Pencil or writing instrument 

## BUILDING PROCEDURE

- 1) Students decide on teams of 2-4.
- 2) All teams receive the same amount of supplies.
- 3) Each person will take 5 - 7 minutes to sketch out their own engineering plan for building the antenna or satellite.
- 4) The team comes back together sharing each design with one another. The team then decides which elements to use from each drawing to begin building the final product.
- 5) The team has 10-15 minutes to work together to build *one* antenna or satellite using only the amount of supplies given to them.
- 6) The class will come back together to share designs and discuss.



# Networking Activity: Deep Space Network

AGE 8-ADULT


## OBJECTIVE


With this activity, students will understand a space communications network by acting out NASA's Deep Space Network (DSN). Students will learn that information from NASA satellites is communicated via radio frequency. The DSN is demonstrated by sending data from the spacecraft to the ground station and back to the spacecraft.


The DSN supports NASA and non-NASA missions that explore the furthest points of our solar system. The DSN has three ground stations located approximately 120 degrees apart on Earth ( $120 + 120 + 120 = 360$ ), which is to ensure that any satellite in deep space is able to communicate with at least one station at all times. The ground stations are located in Canberra, Australia; Madrid Spain; and Goldstone, California.

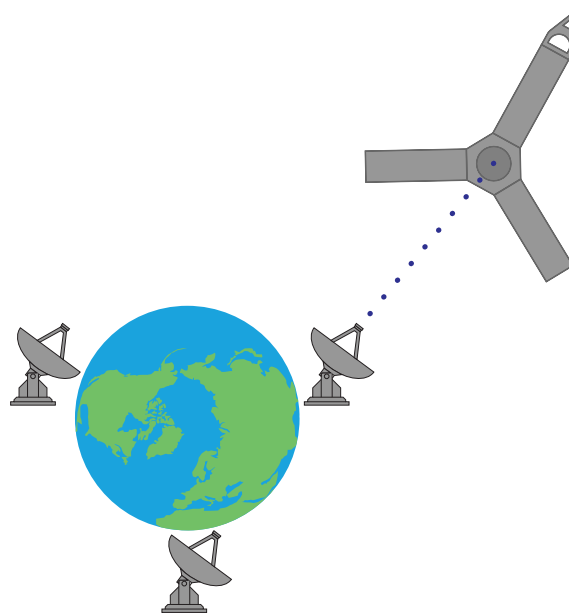
To see the real time status of communications with our deep space explorers visit: [eyes.nasa.gov/dsn/dsn.html](https://eyes.nasa.gov/dsn/dsn.html)

## WHAT YOU'LL NEED

Plastic blow up globe 

Ping pong balls 

Plastic Cups 



## PROCEDURE

- 1) Students volunteer to play the following roles: Earth, three ground stations and a spacecraft of choice (i.e. Voyager, New Horizons, Juno, etc.)
- 2) Students get into place with the Earth in the center, three ground stations at each appropriate location on the Earth (United States, Spain and Australia) with their backs to the Earth and facing out towards space holding one cup each. A spacecraft also holds a cup and ping-pong balls standing far away from Earth on the other side of the room.
- 3) The ground stations will stand very close to the Earth and rotate with it. The spacecraft will walk or toss the ping-pong ball, which is a representation of data, to the ground station that is closest to the spacecraft. The ground station will then walk or toss the ping-pong ball back to the spacecraft. Now, the spacecraft will walk or toss the ping-pong ball to another ground station. To make the demonstration more complex, more students may be added as additional spacecraft sending data to the ground stations.

# Networking Activity: Near Earth Network

AGE 8-ADULT


## OBJECTIVE


With this activity, students will understand a space communications network by acting out NASA's Near Earth Network (NEN). Students will learn that information from NASA satellites is communicated via radio frequency. The NEN is demonstrated by sending data from the spacecraft to the ground station and back to the spacecraft.

The NEN provides telemetry, commanding, ground-based tracking, data and communications services to a wide range of customer with satellites in low Earth orbit, geosynchronous orbit, highly elliptical orbit, Lunar orbit and missions with multiple frequency bands. The NEN dedicates ground stations around the world to mission-critical communications coverage. NASA owns a number of ground stations, but the network also contracts out coverage from commercial stations. Together, they comprise more than 20 sites covering more than 40 spacecraft.

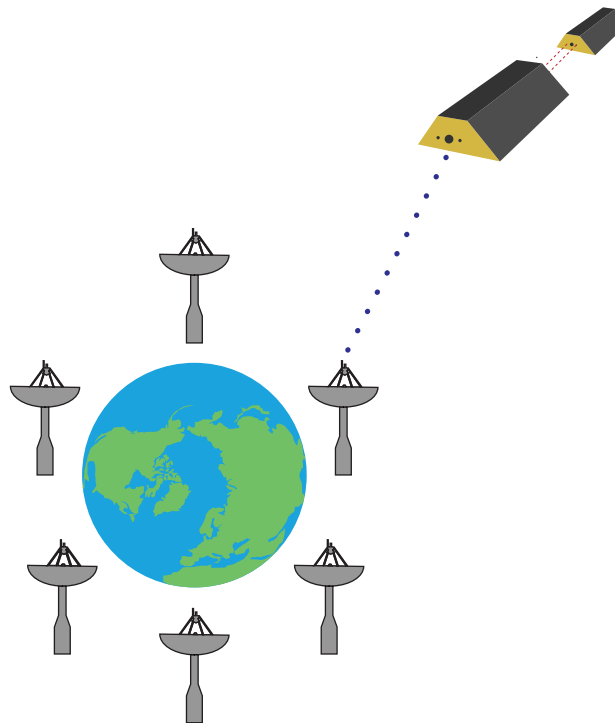
To see the real time status of communications with spacecraft, visit: [scan-now.gsfc.nasa.gov/nen](https://scan-now.gsfc.nasa.gov/nen)

## WHAT YOU'LL NEED

Plastic blow up globe 

Ping pong balls 

Plastic Cups 



## PROCEDURE

- 1) Students volunteer to play the following roles: Earth, 5-10 ground stations and a spacecraft of choice i.e. Geostationary Operational Environmental Satellite (GOES).
- 2) Students get into place with the Earth in the center, 5-10 ground stations around the Earth holding one cup each with their backs to the Earth, and a spacecraft holding a cup and ping-pong balls.
- 3) The ground stations will stand very close to the Earth and rotate with it. The spacecraft will walk or toss the ping-pong ball, which is a representation of data, to one of the ground stations. The ground station will then walk or toss the ping-pong ball back to the spacecraft. Now, the spacecraft will walk or toss the ping-pong-ball to another ground station. To make the demonstration more complex, more students may be added as additional spacecraft sending data to the ground stations.




# Networking Activity: Space Network


AGE 8-ADULT

## OBJECTIVE

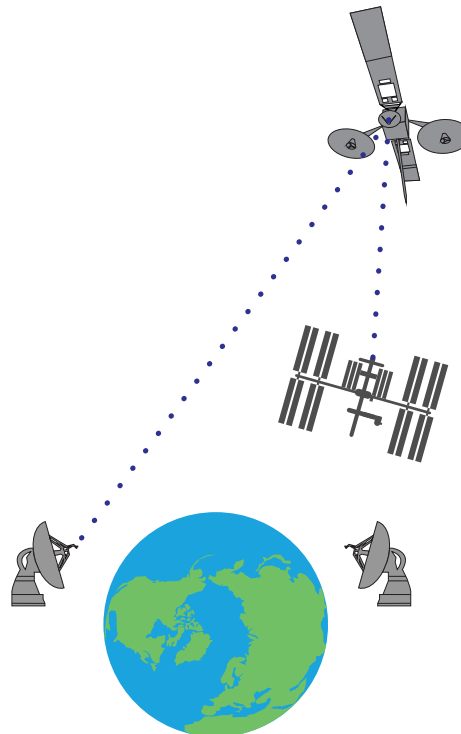
With this activity, students will understand a space communications network by acting out NASA's Space Network (SN). Students will learn that information from NASA satellites is communicated via radio frequency. The SN is demonstrated by sending data from the spacecraft to the ground station and back to the spacecraft. The SN consists of geosynchronous Tracking and Data Relay Satellites (TDRS) and ground systems that relay information to and from spacecraft in low Earth orbit.

## WHAT YOU'LL NEED

Plastic blow up globe 

Ping pong balls 

Plastic Cups 



## PROCEDURE

- 1) Students volunteer to play the following roles: Earth, two ground stations, up to ten TDRS and one International Space Station.
- 2) Students get into place with the Earth in the center, two ground stations around the Earth holding one cup each with their backs to the Earth, 1-10 TDRS holding one cup each, and the International Space Station holding a cup.
- 3) Students acting as ground stations will stand very close to the Earth. The student representing the International Space Station in low Earth orbit will be next and stand further out from the ground stations. The student(s) representing TDRS will stand the furthest away and rotate with the Earth in geosynchronous orbit (following the direction of the Earth's orbit). The International Space Station will walk or toss the ping-pong ball, which is a representation of data, to the closest TDRS. The TDRS will walk or toss the pin-pong ball down to one of the ground stations. Now, one of the ground stations will walk or toss the ping-pong- ball to another the closest TDRS. The TDRS will then walk or toss the ping-pong ball back to the International Space Station.

## Learn more about Space Communications and Navigation (SCaN)

Visit [www.nasa.gov/scan](http://www.nasa.gov/scan).

Follow NASA SCaN on social media:



@NASASCaN



@NASASCaN

## Learn more about Exploration and Space Communications Projects Division (ESC)

Visit [esc.gsfc.nasa.gov](http://esc.gsfc.nasa.gov)

Follow NASA ESC on social media:



@NASA.ESC

Follow NASA TDRS on social media:



@NASA\_TDRS



@NASA.TDRS

Follow NASA LaserComm on social media:



@NASALaserComm