UAH ARISS Program 2013

Program Proposal
Day 1 – Radio Waves & Amateur Radio  
Day 2 – Simulated ISS  
Day 3 – Tracking & Doppler  
Day 4 – Event Day Training  
Day 5 – Event Day  

Week of February 11  
Week of February 18  
Week of March 4  
Week of March 11  
Week of March 18
ARISS Day 1 Description:

This is broken into two parts. First, we will teach waves. Second, we introduce amateur radio and let the students each operate and talk over a basic amateur radio.

**Waves**

**Day 1 Presentation – Part 1**  
Waves lecture will cover material and use the slides below.

**Hands On Activity - Ruben’s Tube**  
This is a plastic tube with 1/16” holes drilled down its length every ½”. A metalized tape covers the top to prevent burning the plastic. With gloves covering each end of the tube and a propane grill supply tube inserted into 4 locations, an even amount of small flames can be successfully generated. Make sure to do this in open air with wind blocks. Next, a 2” to 3” speaker should be placed at one end. Propane is fed through the tube and lit on fire. When the speaker is turned on, the pressure from the sound waves causes the flames to mimic the sound wave. This means that the students will get to “see” a kind of wave discussed in the lecture. There are many how-to videos on building Ruben’s Tubes, such as this. [CLICK HERE](#).

The speaker at one end of the tube will play a tone at a certain frequency. A Space Hardware Club team member will measure the amplitude and wave length of the flame wave produced and the students will record it. They will then make basic calculations about the wave they’ve seen. For fun, a familiar song will also be played so the students can see the effect of the sound waves on the flame.

Note  
This experiment is entirely safe but will be performed outside and students will not be near the flames. There will be a black background behind the Rubens tube so the flames are easily visible.

**Radio**

**Day 1 Presentation – Part 2**  
Radios lecture will cover material and use the slides below.

**Hands On Activity – Amateur Radio**

The second part of this activity involves the students using the HAM radios to communicate with each other across a field. The handout requires them to write their conversation before they commence the activity. They will be under the supervision of the Space Hardware Club team.
Lesson 1

Radio Waves
How Much Do You Know About Waves?

• Where do they come from?

• What are they used for?

• What are they made of?
What Is a Wave?

• A wave is a vibration that moves energy.

• A wave is energy moving through a substance. (And even deep space is connected with a very thin material, the interstellar medium)

• It can be either physical pressure, like sound, or electromagnetic. Waves such as radio, light, and x-rays are electromagnetic waves.
Waves

- **Wavelength** - Distance between two peaks
- **Amplitude** - Distance from equilibrium to peak
- **Node** - Point of equilibrium
- **Period** - Time between two peaks
- **Frequency** - Number of wavelengths in a given time
- The wave velocity can be found by multiplying the wavelength and the frequency. For EM waves, this is always 299,792,458 m/s (980,000 ft/s) in vacuum.
Behavior of Waves

• Refraction- Bending waves by changing their velocity.

• Reflection- Bouncing waves off a surface.

• Diffraction- Splitting waves into many waves of different frequencies.

• Interference- Distorting waves by transmitting other waves through them.
Behavior of Waves

- Refraction
- Reflection
- Diffraction
- Interference
Lesson 1

Amateur Radio
Amateur Radio

• Governments around the world allow us to talk on certain frequencies with certain transmission power.

• The rules say we can use amateur bands if we don’t get paid for it and we do get licensed to use it.

• In the US, we commonly use 10 meter, 2 meter, and 70 centimeter wavelengths to talk and send data.

• We communicate with each other, balloons, satellites, even astronauts!
Amateur Radio

• In the US, we commonly use 10 meter, 2 meter, and 70 centimeter wavelengths to talk and send data.

Convert these three wavelengths to frequencies. Remember multiplying the wavelength and the frequency gives 299,792,458 m/s, speed of light.
Using the Radios

• Let’s use the radio to talk to a friend.
• To use an amateur radio, we have to choose a frequency.
• Let’s find an open frequency that amateur radio operators are allowed to use for voice.
U.S.A. Amateur Radio UHF/VHF Band Plan

- 1240 band
  - 1240 MHz
  - 1246 MHz
  - 1252 MHz
  - 1258 MHz
  - 1260 MHz
- 900 band
  - 902 MHz
  - 904 MHz
  - 906 MHz
  - 907 MHz
  - 910 MHz
  - 916 MHz
  - 918 MHz
  - 919 MHz
  - 922 MHz
  - 928 MHz
  - 907.1 SSB
- 440 band
  - 420 MHz
  - 426 MHz
  - 432 MHz
  - 432.125 MHz
  - 433 MHz
  - 435 MHz
  - 438 MHz
  - 442 MHz
  - 445 MHz
  - 447 MHz
  - 450 MHz
  - 432.1 SSB
  - 446 MHz
- 222 band
  - 222 MHz
  - 222.34 MHz
  - 223 MHz
  - 223.38 MHz
  - 224 MHz
  - 225 MHz
  - 222.1 SSB
  - 228.5 FM
- 2 meters
  - 144 MHz
  - 145 MHz
  - 146 MHz
  - 147 MHz
  - 148 MHz
  - NO FM
  - NO FM
  - NO FM
  - NO FM
  - NO FM
  - SSB
  - SSB
  - SSB
- 6 meters
  - 50 MHz
  - 51 MHz
  - 51.1 MHz
  - 52.05 MHz
  - 53 MHz
  - 54 MHz
  - DX Window
  - Radio Control
  - National Calling Frequency
  - Radio Control (Old)
  - Satellite Only
  - Satellite Only

- Amateur TV Fast Scan
- Satellite
- CW & Weak Signal (No FM)
- Digital
- FM Simplex
- SSB
- FM Repeater
Using the Radios

• Again, start by saying your call sign.
• Now we can say anything appropriate.
• Repeat your call sign every 10 minutes and when you’re finished with your conversation.

• Now what would you say? Write it down.
• Did you know? If you want to call for someone, simply say their call sign followed by your call sign!
Using the Radios

• Great! Let’s use 146.600 MHz. It’s a normal choice for our team when we are on the road.
• Next, how do we start to talk over the radio?
• We are taught that you have to start with your call sign. The government gives each personal with a license a call sign. When we group up, we use a club call sign.
Convert these three wavelengths to frequencies. Remember multiplying the wavelength and the frequency gives 299,792,458 m/s, speed of light.

Example:

Wave Length (λ): 10 Meters
Frequency (f): \( \frac{299792458\text{ meters}}{10\text{ meters}} \) Hertz

\[
\frac{299792458\text{ meters}}{10\text{ meters}} = \frac{29979245\text{ meters}}{\text{second}} = 29979245\text{ Hz} = 29.979\text{ MHz}
\]

Question 1

Wave Length (λ): 2 Meters
Frequency (f): ______________ Hertz

Question 2

Wave Length (λ): 70 Centimeters
Frequency (f): ______________ Hertz
ARISS Day 1 Activity

Amateur Radio Activity Handout

Name: ____________  Teacher: ____________

Call sign: ____________

Frequency for talking: ____________

With your friend, write down your radio conversation below.

• Again, start by saying your call sign.
• Repeat your call sign every 10 minutes and when you’re finished with your conversation.
• If you want to call for someone, simply say their call sign followed by your call sign!

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
ARISS Day 2 Description:

Day 2 will consist of a lecture, activity, then a wrap up lecture.

The International Space Station

Day 2 Presentation – Part 1

The ISS lecture will over the material and use the slides below.

Hands On Activity – ISS Relay

The second lesson plan on the ISS comes with an activity involving a few stations the students rotate through. The activities, described on the handout, will be closely monitored by the Space Hardware Club team.

There will be a full sized outline of three ISS modules on the floor that the students will be conducting their activities in. One of the activities calls for a Dragon capsule which will also be outlined or constructed.

Position 1 – Environmental Testing
Position 2 – Physiological Training
Position 3 – Cargo Handling

Day 2 Presentation – Part 2

The Astronaut lecture will over the material and use the slides below.

Handout - During this astronaut lecture, students will be asked to write a question to ask the astronaut.
Lesson 2

The International Space Station
What is it?
International Space Station

• An international laboratory for the world’s scientists to study things in microgravity
• Microgravity is what you experience when you freefall towards Earth
What is it?

International Space Station

- If you fly away at the same speed you fall, you float like an astronaut.
- We research cancer medicines, the sun, and even how the human body behaves without the force of gravity.
Countries on the International Space Station

Belgium
Brazil (INPE)
Canada CSA
Denmark (DSRI)
France (CNES)
Germany (DLR)
Italy (ASI) (SAI)
Japan (NASDA)

Netherlands (NLR)
Norway (NSC)
Russia (PKA)
Spain (INTA)
Sweden (SNSB)
Switzerland (SSO)
United Kingdom (UKSA)
United States (NASA)
The Astronauts

• 6 at all times.
• Three go up at a time, every 3 months, and stay for 6 months.
• Primary job: perform experiments, move payload, maintenance hardware, stay in healthy, teach the public
Activity:
Learn about the Station
Environmental Testing
Physiological Training
Cargo Handling
Ask an Astronaut

• Take 5 minutes and think about what you might ask an astronaut.
• Write down what you would ask an astronaut.
• Make sure yours is different from your neighbors.
How much air is in the space station?

837 m³

• Convert this to cubic feet.
• Remember, 1 m = 3.28084 ft

• Answer is on next slide.
837 m³ = 29,600 cu ft
ARISS Day 2 - Simulated ISS – Position 1

Name: ___________   Teacher: ___________

Environmental Testing - Kibo Lab (Japan)

Experiment A) Surface Tension – Inflate a bubble by blowing then by waving wand. Measure time before pop and approximate size of each mechanism.

<table>
<thead>
<tr>
<th>Blowing</th>
<th>Time:</th>
<th>Size:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waving</td>
<td>Time:</td>
<td>Size:</td>
</tr>
</tbody>
</table>

Experiment B) Spectroscopy: Identify the primary lines for each of the light sources. Fill in information below.

<table>
<thead>
<tr>
<th>Source A</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Source B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source E</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Experiment C) Magnetic Tower Test: Build each of the three towers as tall as possible and record the height in centimeters below.

<table>
<thead>
<tr>
<th>Test A</th>
<th>cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test B</td>
<td>cm</td>
</tr>
<tr>
<td>Test C</td>
<td>cm</td>
</tr>
</tbody>
</table>
ARISS Day 2 - Simulated ISS – Position 2

Name: ____________  Teacher: ____________

Physiological Training - Destiny Laboratory (US)

Experiment D) Pedaling Machine. Astronauts shall use the pedaling machine for 1.5 minutes recording heart rate and speed at each of the following points.

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Beats per minute</th>
<th>MPH</th>
<th>m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Experiment E) Blood Pressure. Each astronaut shall each take blood pressure on from three different positions. Record your individual results below. You can keep these numbers private. This experiment should be assisted by a professional. Astronauts should only perform tasks they are comfortable performing.

<table>
<thead>
<tr>
<th>Position</th>
<th>Systolic mm Hg</th>
<th>Diastolic mm Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laying Down</td>
<td>Systolic mm Hg</td>
<td>Diastolic mm Hg</td>
</tr>
<tr>
<td>Sitting</td>
<td>Systolic mm Hg</td>
<td>Diastolic mm Hg</td>
</tr>
<tr>
<td>Standing</td>
<td>Systolic mm Hg</td>
<td>Diastolic mm Hg</td>
</tr>
</tbody>
</table>
Cargo – Harmony Connecting Node (US)
Dragon Capsule (SpaceX)

Experiment F) Transfer the entire contents through the Harmony Connecting Node. Each box must be placed into its correct position without being damaged or dropped and can only be moved by handles.
ARISS Day 2

What would you ask an astronaut?

Name: ____________  Teacher: ______________

Period: ____________

Question:
ARISS Day 3

Summary

The third day of ARISS will be used to teach the students about tracking satellites as well as Doppler shift, both important to the project.

**Tracking Presentation – Part 1**
This lecture does not include a power point but will have an STK model of the ISS that will be projected for the students to see. STK will create an awareness of where the ISS is in space. Included in this folder is a power point of this lesson’s outline. There will be an equation taught to the student but they will not be expected to use it in calculations.

**Tracking Activity**

**Doppler Shift Presentation – Part 2**
The students will also be taught about Doppler shift using a whistling nerf football on a string.
ARISS Day 3
Discussion

Tracking

Background

Orbit of a satellite in space; ISS as an example in orbit

In order to communicate; Directional tracking and pointing

When can you see it? When the sun is shining on the satellite but not shining on us

Iridium flares

Doppler Effect

Sound

Coming towards you

Going away from you

Noise Maker

Ambulance driving by – youtube video

Nerf football on string

Math:

\[ f = \left( \frac{c + v_r}{c + v_s} \right) f_0 \]

Simulation

Modeling from different perspectives:

Earth vs. Satellite

Ground Station vs. Satellite

- Viewer with instructions
- Make a movie file
ARISS Day 3 Activity
Tracking and Doppler Shift

Each student will have the chance to track a satellite. Here’s how.

**Step 1**
A laser pointer will be set up to spin slowly, streaking a dot across the ceiling of the classroom every minute or so.

**Step 2**
Each student will drive a flashlight using an RC controller. The flashlight will be connected onto two servos that control azimuth (twist angle) and elevation (angle off the horizon). Students should attempt to keep the dot centered in the flashlight beam. To increase difficulty, speed up laser rotation speed.

*Multiple tracking stations can be set up in classroom for the same satellite.*
ARISS Day 4
Event Training Day

This day, we will practice talking to an astronaut over the radio. On the future event day, we will have approximately 10 minutes talking to the astronauts; each student will have 1 minute for asking the question and getting the answer.

**Part I (20 min)**
To start the class period, we will review how to talk over the radio.

**Part II (40 min)**
Each student will key up on the radio and get to ask his/her question. We will have someone respond on the radio to each student. Another activity is still in planning to keep these student excited after each gets to use the radio.

Separately in a different room, the 2 students from each class that have the selected questions and two backup students will get to participate in a similar program, but will utilize the actual radio hardware used on flight day. They will also get to practice their questions multiple times.

**Part III (15 min)**
We will mock the station passing over. With set start and finish times up front, we will have the 4 students ask their actual questions over their actual hardware. We will have a stand-in astronaut answer in the timeframe provided. The 4 students will perform in front of the class.