UNIVERSITY OF NEBRASKA AT OMAHA

Bubbles, Biology, and the Beyond

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Introduction

Our Near Space Experiment included a bubble wrap experiment and a Mold experiment.

Field Experiment:

The objective of our field experiment was to inquire the existence of mold in the upper atmosphere. The idea for this experiment was sparked from a previous one at the beginning of the year. The class was to test the existence of mold spores within our building. To our surprise mold spores were very relevant and this lead to the question "Is there mold everywhere?"

True Experiment:

The Objective of our true experiment was to compare the effects water had on pressure. We produced idea while discussing how our ears pop on airplanes. "If our ears pop on airplanes, what would happen to bubble wrap?". This led us to compare bubble wrap in a container of air and one in water.

Design

Identify the Variables:

Independent (Field): 2400 feet- altitude set for the box to open Dependent (Field: Mold spores in the air Control (Field): Procedural safeguards for the box

Independent (True):Atmospheric Pressure Dependent (True): Bubble wrap condition (popped or not) Control (True): Temperature inside module, water in one container

Detail of Procedures:

Field:

For the field experiment the group handmade a box out of plexiglass and attached a servo motor to open and close the door. The perimeter was wrapped in foam to protect it when the module landed after the flight. When the module reached an altitude of 2400 feet, the raspberry pi told the servo motor to open the door for 5 minutes. During that time the Q-tips were collecting mold spores. To analyze the results, the group took each Q-Tip and rubbed it on a mold collecting sheet and grew mold.

True:

Cut the bubble wrap into even strips and place one strip in each bottle. Then fill one bottle with water. Secure the hand warmers to the sides of the bottles, then secure everything to the module using Velcro and packing tape, do the same with your go pro and raspberry pi. After the launch is complete, take the bubble wrap out of the bottles and record the observations

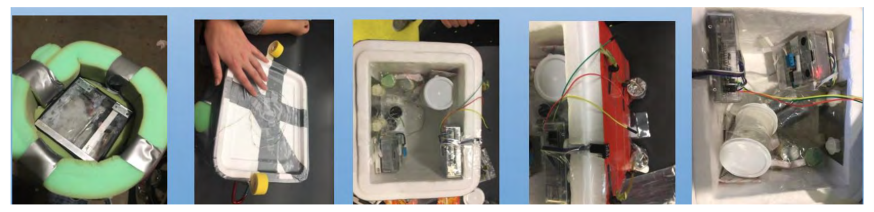
Materials List:

Field Experiment:

Plexiglass box, Altimeter, HS-311 Standard Servo Motor, Gauze Pad, Q-Tips, Mold growing kit, Foam

True Experiment:

Go-Pro, Travel-sized shampoo bottles, bubble wrap, hand warmers



Research Questions/Hypotheses

Field:

RQ: Is mold present in upper atmosphere of 24,000 meters?
H: We predict that mold does not exist in the upper atmosphere of 24,000 meters?

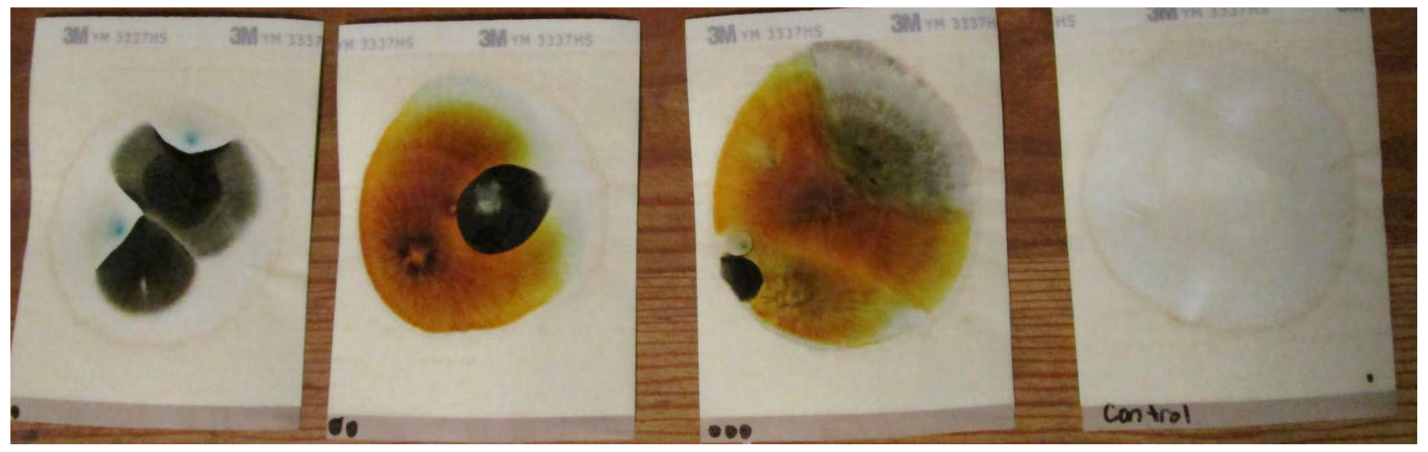
True:

RQ: Does the change in high altitude effect bubble wrap differently in a container of water versus a container of air?
H: We predict that the bubbles in the water-filled container will not pop and the water in the air-filled container will pop.

Results/Findings

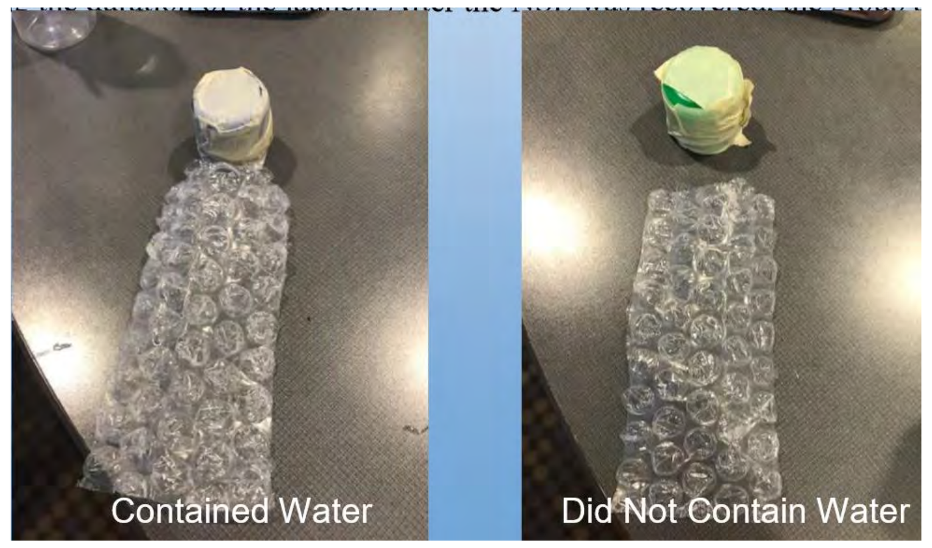
Field Experiment:

We found that mold does exist in the upper atmosphere. The control swab grew no mold spores. The first mold sheet has two green spots with a black nucleus. It also has two small teal masses as well. The second has an orange growth with two black growths on the inside. The last slide has a mixture of the green and two orange masses, There is a black growth on one of the two orange growths. This growth was exposed on day 16 of growth.



True Experiment:

For the true experiment we found that none of the bubbles from either container had popped. However, we did find that the bubbles in the container of air came back less elastic. They looked and felt less firm.
These result were inconclusive.



Conclusions

For the field experiment, we found the box containing the Q-tip completely closed with no damage and the Q-tip still safely secured within the box. The programming of the box went without any problems, and the cotton swabs were exposed to the atmosphere for five minutes. However, none of the program was recorded due to the fact that as soon the box closed the programming stopped and reset itself. Also lack of materials postponed our result discovery for a few days. Once we had the materials necessary, we swabbed the
Q-tip on a mold sheet and then let it sit, we found many of mold spores that grew on the sheet. That indicated that the atmosphere does contain mold. These results supported our hypothesis.

We found our true experiment did not work as we planned. Both of the bottles came back with no damage, they were still tightly sealed. Neither of the bottles that contained the bubble wrap had been drastically affected. The sheets of bubble wrap was pretty much the same except for the bottle that contained water. The bubble wrap in the air-filled container seemed more elastic and not as firm. That indicated that the atmospheric pressure had little to no effect on the bubble wrap, which did not support our hypothesis.

Future Direction

- Change the tubing around the box
- Revise the coding to ensure it collects data
- Un-make the program startup tied to the raspberry pi start up
- Make the plexi-glass box smaller
- Use bigger Q-tips or Replace Q-tips with mold kit growth sheets.
- Start the process of swabbing the mold samples sooner

Acknowledgements
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University of Nebraska Omaha

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Cosmic Rays and Atmospheric Correlation

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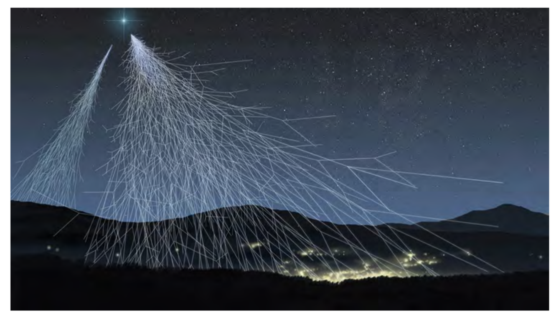
Introduction

True Experiment: Cosmic rays are atom fragments from exploding stars that rain down on the Earth from outside of the solar system. They are high energy particles that move through space at nearly the speed of light. Most cosmic rays are atomic nuclei stripped of their atoms with protons. NASA cargo is occasionally exposed to radiation large enough to form exposures on photographic flight film.

Quasi Experiment: Weather balloons are used to carry weather instruments that measure temperature, pressure, humidity, and winds in the atmosphere. When the balloon increases in altitude, the pressure increases as well.



Design

True Experiment Variables
- Independent- The types of undeveloped film and their orientations
- Dependent- Evidence of cosmic rays
- Control- Styrofoam cooler, wool sock, and hand warmers
- Constraints- Weight of the payload, funding for the project, and no light exposure on the film.

True Experiment Procedure
- Measure the Fujifilm strip 13.5 cm and cut the strip. Secure the Ilford film to the bottom of the box with duct tape.

True Experiment Materials
- Duct Tape
- Iphone 6 box
- Thumbtacks
- 1 roll of Ilford DELTA 3200 Professional, Black and White Print Film, 120 (6 cm)
- 1 roll of 35mm Fujifilm 400 speed film
- 3 hand warmers
- Wool sock
- Ruler marked with duct tape

Inside of "Dark Box" without our actual film laid out.

Quasi Experiment Variables
- Independent- Payload
- Dependent- Temperature, altitude, and speed
- Control- No control for our Quasi experiment
- Constraints- Weight of payload and funding for the project

Quasi Experiment Procedure
- Connect the BMP280 sensor to raspberry pi using the male-to-male jumper wires. Connect the raspberry pi to the lithium mobile battery with the USB power cord.

Quasi Experiment Materials
- SunFounder BMP280 Barometric Pressure Temperature Altitude Sensor (Altimeter)
- Raspberry Pi
- Gomadic Lithium Rechargeable Battery Pack
- USB to micro USB cable
- 3 Male-to-male jumper wires

Research Questions/Hypotheses

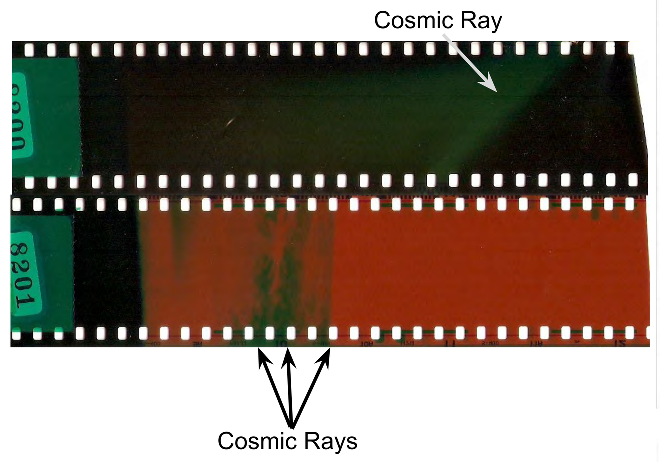
True Experiment: This true experiment is to see how cosmic rays affect undeveloped film in a controlled environment.
Hypothesis: We predict that once we develop our film, cosmic rays will be visible in the form of white streaks

Quasi Experiment: This quasi-experiment is to look at the correlation between temperature, altitude, and the speed that the weather balloon travels at.
Hypothesis: We predict that as altitude increases, temperature decreases and the speed will decrease.

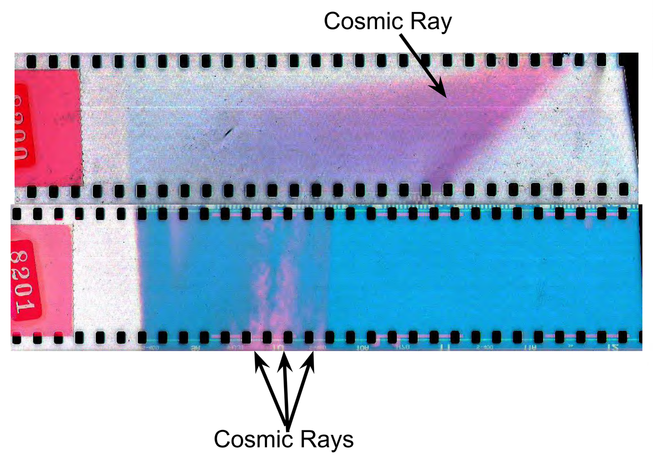
Results/Findings

True Experiment

The images below are the original scanned strips of film.

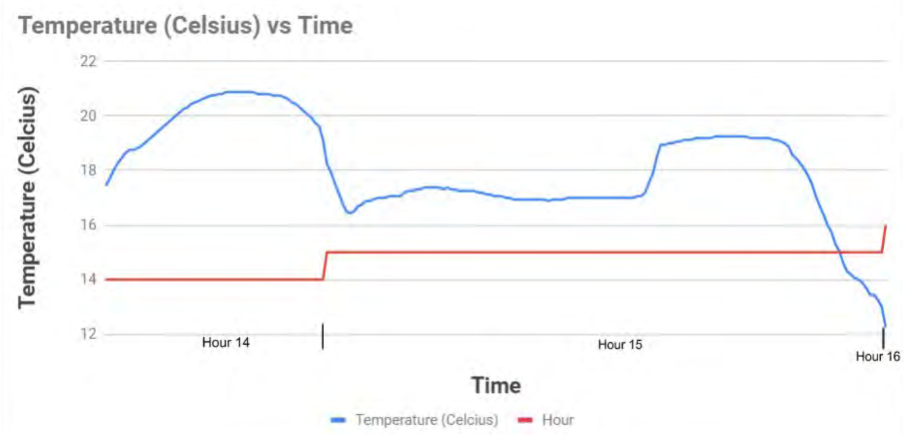


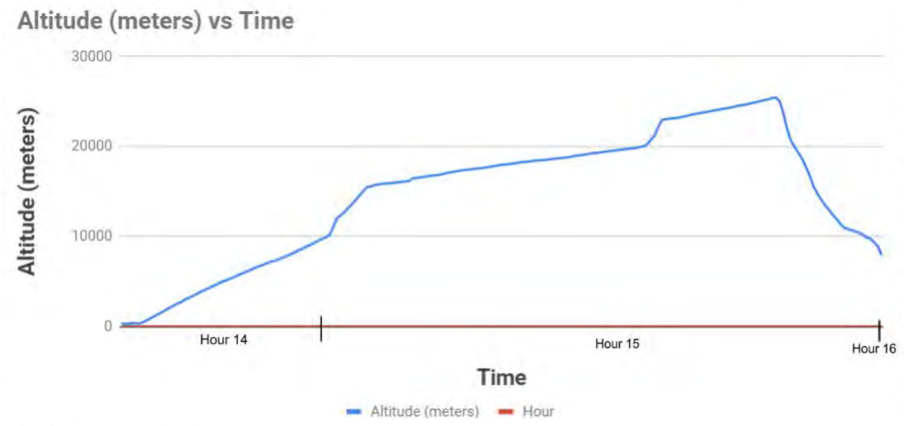
The images below were inverted to show the cosmic rays better.

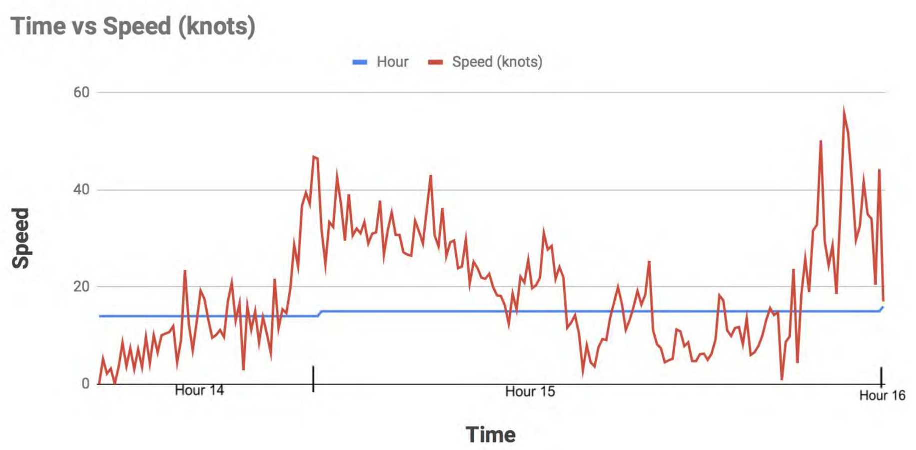


Quasi Experiment

The data used for the graphs below are the results from the command module sensors.







Conclusions

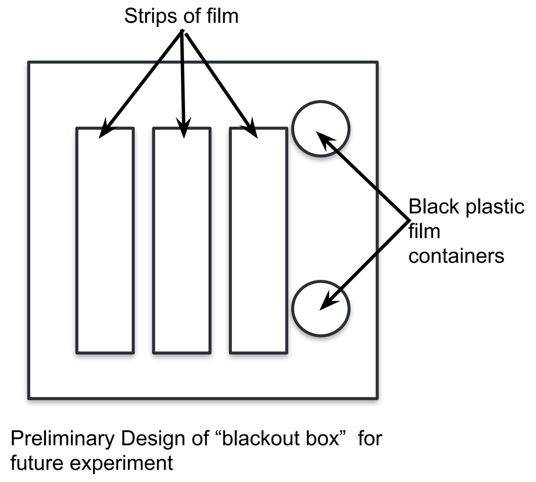
True Experiment:
We have concluded that we did catch evidence of cosmic rays for the following reasons:
- We know that the images we got on our film are not accidental exposures to light.
- The photo professionals at Rockbrook did not know what it was.
- We know that if the film had been exposed to light, all of the film would be black.

Quasi Experiment:
We have concluded that the temperature overall did decrease as the altitude increased and it is not quite as clear, but we also feel that the speed overall decreased as the altitude increased.

Successes:
- We did capture evidence of cosmic rays.
- Our sensor was able to collect data throughout most of the flight.
- Our hypotheses were, for the most part, correct.

Failures:
- We did not get any results on our most sensitive film.
- Our sensor stopped recording some time throughout the flight.
- We were not able to use the data from our sensor.

Future Direction



Preliminary Design of "blackout box" for future experiment

True Experiment: We would use a larger dark box to put into our module. This way we could lay out a few strips of film around the box which we think would increase our chances of capturing more cosmic rays.
Quasi Experiment: We would purchase a sensor that only measures altitude instead of the BMP sensor because the formula for the altitude from the pressure and temperature were not compatible with Excel.

Acknowledgements
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NSE Crickets & Plants

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Introduction

True Experiment - Plants
The goal of our true experiment was to better understand how temperature and altitude affect how plants are grown. Space experiments and research can make a huge impact on the world we live in. During our Quasi experiment we conducted a study to experiment how plants grow within a variety of topography, vegetation, altitude and temperature. After research we found that sunflowers and pinto beans are known for having had the most success while being experimented with in space.

Field Experiment - Crickets
The goal of our field experiment was to determine if temperature and altitude would affect if crickets can survive on a journey into space. Crickets need to have a certain amount of oxygen to survive. We tested to see if the amount of oxygen in their containers would work, they lived 24 hours in the containers and then we released them. The ideal range of temperatures crickets can live in is from 70 to 75 degrees Fahrenheit.

Design

Variables:
Cricket containers- Needed to be small, give off enough oxygen, have a removable lid, be stackable, and clear for the GoPro
Hand warmers- Able to control the temperature for the crickets
Plant containers- Needed to be small, Horizontal, have a removable lid, and be large enough to be zip tied
Plastic Wrap- Needed to prevent dirt from spilling, needed to keep stem upright
Space- Take up as little space as possible to fit another group
Weight- Weigh the least amount to meet the requirement and be able to fly

Crickets Procedure:
- Gathered the materials we needed
- Researched information on crickets and their living conditions.
- Purchased the crickets and observed them for 24 hours, a month before our experiment
- Programed the humiture using the Raspberry Pi.
- Tested the data using a hand warmer to change the temperature and record data
- Began to assemble our module in preparation to send it into near-space
- Preparing for launch we secured the containers to the module using Velcro strips
- Activated the hand warmers secured with zip ties and tape and plugged in humiture.
- Examined the crickets when the landed and recorded data

Plants Procedure:
- Researched plants with the highest survival rate in space.
- We tested the humitures data by using a hand warmer to change the temperature
- Purchased the plants online and began to grow them in plastic film containers
- Over 2 weeks watered them, kept them in sunlight, and closely monitored them
- Secured the plants in the film containers to the module using velcro strips
- Secured the top of the canisters with plastic wrap, then wrapped it around plant stems to ensure the dirt wouldn't fall out
- Examined the plants when they landed
- Monitored them everyday to determine if space affected the growth of the plants

Materials: One Raspberry Pi , humiture sensor, two GoPro's, four film canisters, three hand warmers, eight 68-mL containers, plastic wrap, one battery pack, two sunflower seeds, two pinto beans, Miracle Grow soil

Research Questions/Hypotheses

Crickets
Research Question: How will the variation in temperature and altitude affect the chances of survival for the crickets?
Hypothesis: Our group predicts that the crickets on the inside of the module will have better chances of survival than the crickets on the outside, which we predict will die.

Plants
Research Question: How does the variation in temperature and altitude affect the growth of a Sunflower and Pinto Bean?
Hypothesis: Our group predicts that the growth of both plants will not be affected in the week following the launch.

Results/Findings

Field Experiment Data Table

	Survived Trip?	Location
Cricket 1	Yes	Inside
Cricket 2	Yes	Inside
Cricket 3	Yes	Inside
Cricket 4	Yes	Inside
Cricket 5	No	Outside
Cricket 6	No	Outside
Cricket 7	No	Outside
Cricket 8	No	Outside

The temperature outside the module got as low as -44.94 degrees celsius and the humidity got as low as 13.6%. All four crickets on the inside of the box survived. One of the crickets escaped on the inside of the module and was still able to live All four crickets on the outside of the module did not survive. We believe they survived due hand warmers on the inside of the module making it a temperature the crickets were able to survive in. Unfortunately, we lost the humitures data and are not able to prove this data.

True Experiment Data Table

	Height on Recovery (cm)	Height 7 Days after Recovery (cm)	Color Before Launch	Color After Launch	Stem Stiffness Before Launch	Stem Stiffness After Launch
Sunflower Inside	0.0	0.0	NA	NA	NA	NA
Sunflower Outside	2.6	2.6	Greenish Yellow	Brownish Yellow	Flimsy	Soggy
Pinto Bean Inside	0.4	0.4	Green	Green	Crisp	Firm
Pinto Bean Outside	0.1	0.1	Green	Green	Crisp	Flimsy

The plants did not have and growth affects in the following days after the launch. We took close observation and measured the plants multiple times before and after the launch. In the table to the right we explain the height, color, and stiffness changes in the plants. Before launch some of the plants were ruined and did have effect on the result of this experiment. During launch some of them were also ruined due to the violent ride. After carefully examining them we found that sending the plants up into did not have a major effect on their growth patterns.

Conclusions

Crickets
Our hypothesis was supported, the four crickets on the inside survived due to the warm temperatures produced by the hand warmers. Unfortunately, the four on the outside died due to the extreme cold temperatures and violent ride into space.

To better our experiment ,more test should have been conducted before the launch to check that the containers were properly secure. We also should have tested if the hand warmers can increase the crickets chances of survival when put on the outside of the module.

Errors: One of the crickets escaped on the inside but luckily survived. Inside of the module the GoPro fell at the launch and the containers were not securely fastened and fell around the box during the experiment.

Plants
Our hypothesis was supported, the plants haven't had any growth affects. The plants on the outside are not growing due to being destroyed before launch and the inside plant stems being broken off before launch.

To better our experiment plants should have been grown a lot earlier and multiple plants in to ensure they would be ready for launch.

Errors: Our plants were ruined before the launch. The humiture sensor data was not saved to SD card. The Dandelion did not grow and had to be cut from the experiment.

Future Direction

In the future of our Near Space Experiment we would continue to expand on the experiment we began with. Our plant experiment could be used to create further testing on the conditions specific plants could survive in while being in space.Today NASA continues to test plants to see how it would be possible to grow them on other planets.The crickets can also be tested for similar purpose. We would do further research and experiments to fully determine the conditions they would be able to survive. This could also help determine the conditions for other insects or animals. Overall this experiment optimized could help us understand ways experts are attempting to expand life to other planets

Acknowledgements

We would like to thank Harolds Photos Experts in Sioux City, Iowa for donating clear film canisters. The class for the suggestions made during trial presentations, the group we shared a module with, and Dr. Derrick Nero for guiding us during this experiment.

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Sound and Temperature in a HAB!

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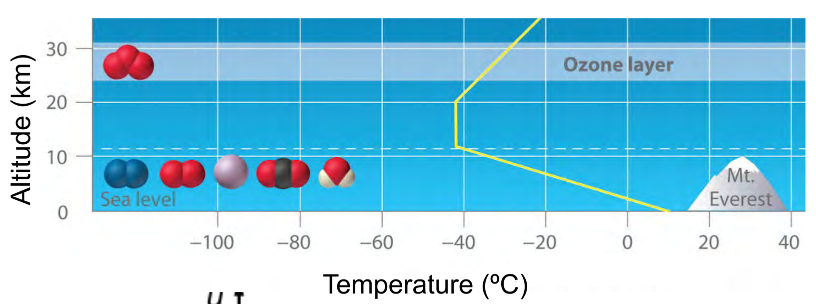
Introduction

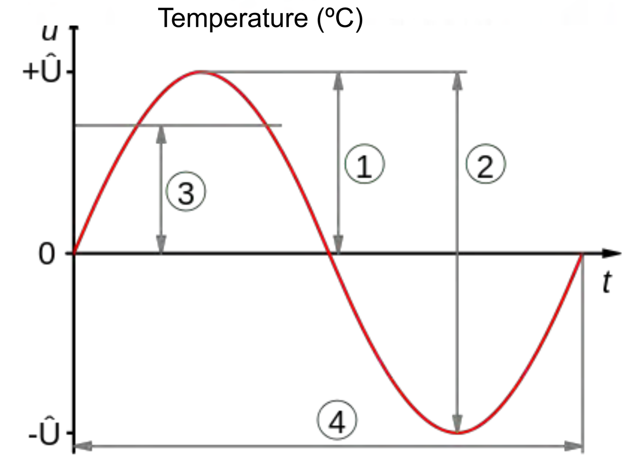
Field Experiment Objective
• To test if altitude is directly related to temperature. Graph shown to the right.



True Experiment Objective
• To gain an understanding of how sound frequencies (pitch) and amplitude (loudness) are affected by altitude.

Frequency (4 on graph)
Measurement of the sound's cycles per second, perceived as pitch and measured in Hertz (Hz).

Amplitude (1 and 2 on graph)
Measurement of the intensity of air molecule vibrations, perceived as volume and measured in decibels (dB).



Design

Variables:

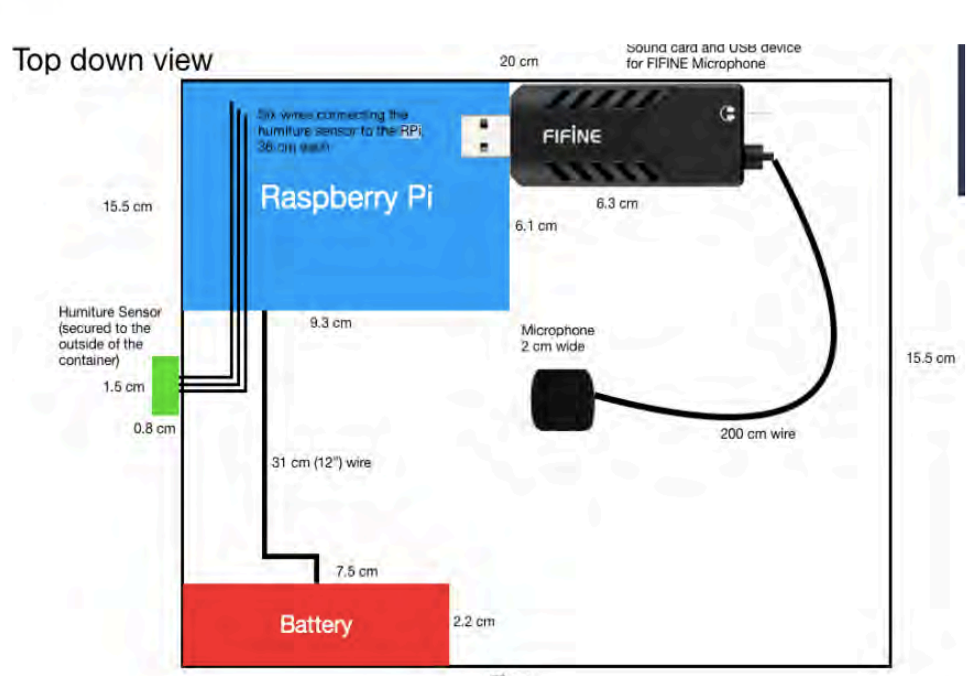
Field Experiment
• Dependent: Temperature
• Independent: Altitude

True Experiment
• Dependent: Sound
• Independent: Altitude, Temperature, and Air Pressure

Procedures
1. Develop Module
2. Test and run software
3. Prepare module for takeoff (run code)
4. Release/Recover high altitude balloon
5. Gather data from Raspberry Pi
6. Develop data into graphs

Materials List
• Raspberry Pi
• Fifine Microphone
• Gomadic battery
• Humidity Sensor
• Python Code

Overview of our first module design



Research Questions/Hypotheses

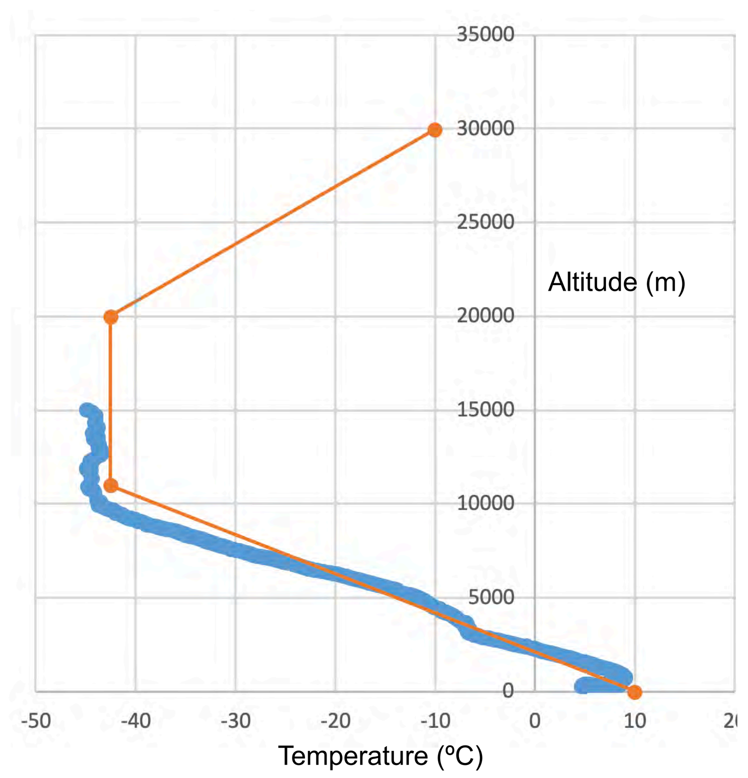
Field Experiment Research Question
• Does altitude directly affect temperature as the high altitude balloon ascends and descends?

Field Experiment Hypothesis
• We hypothesize that the change in air temperature as altitude changes will be directly correlated with other researchers' findings.

True Experiment Research Question
• During the HAB flight, how will the pitch and loudness of sounds be affected?

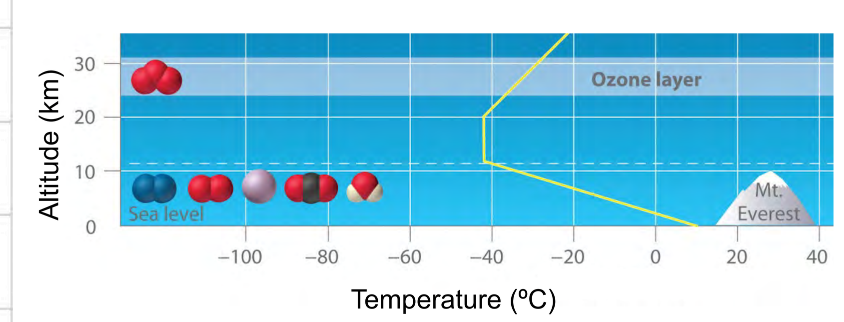
True Experiment Hypothesis
• We hypothesize that sound frequencies and loudness will be decrease as altitude changes.

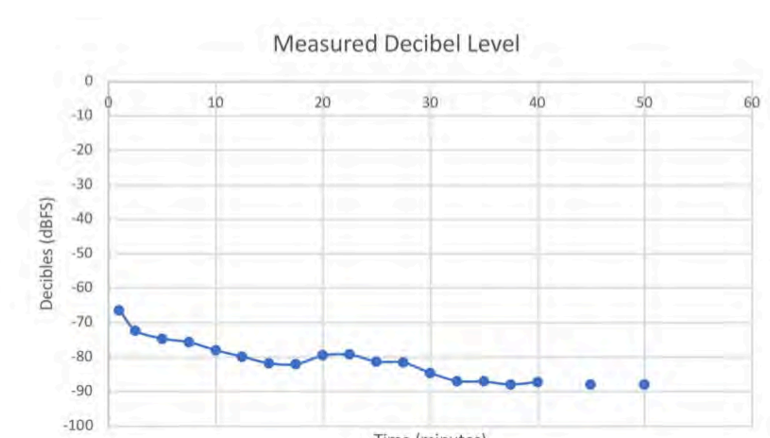
Results/Findings



Field Experiment

The first graph shows the temperature taken from the command module with respect to altitude (show right). The sensor only recorded about 15,000 meters into the flight, then stopped working. The recorded temperature closely follows the model (shown below)





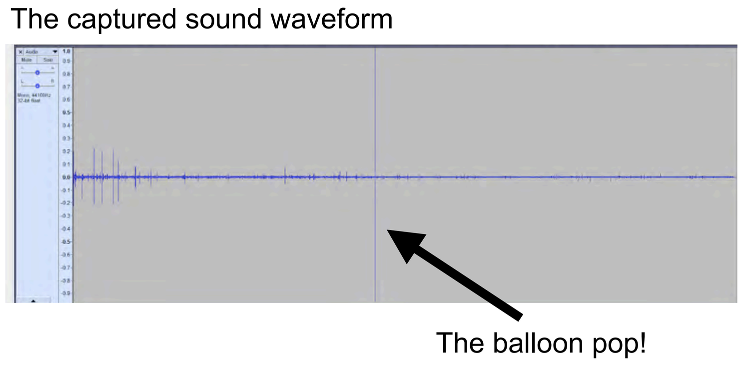
The graph above plots the decibels (loudness) in relation to time every 2.5 minutes

True Experiment

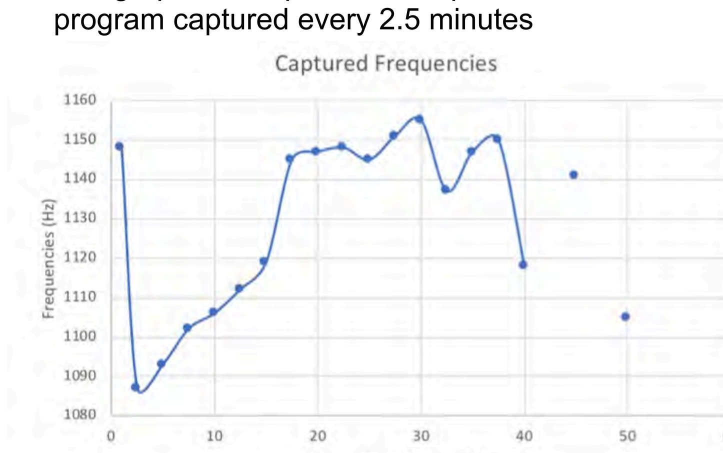
Sound was recorded and analyzed on the Raspberry Pi using Audacity. During the flight, one of the other modules housed a noise maker (a repeating siren sound) with a peak frequency between 1090 and 1150 Hz. We plotted these captured frequencies from the noise maker and the measured dBFS level, a measurement of the sound wave's amplitude using Audacity's Plot Spectrum analyzer.

The results clearly show a decrease in the amplitude, however peaking frequencies are random and are not directly correlated with altitude or temperature.

The captured sound waveform



The graph below plots the frequencies our sound program captured every 2.5 minutes



Conclusions

Field Experiment (Temperature and Altitude Graph)

Using the temperature data from the command module, the graph with respect to altitude lines up very accurately with the temperature model until around 15,000 meters. The temperature sensor on the command module failed to record temperature past 15,000 meters, so our data is incomplete. For the data we did collect, our experiment was a success, however is overall a failure as there was no data gathered for the ascent past 15 km or the descent. Our hypothesis is overall inconclusive.

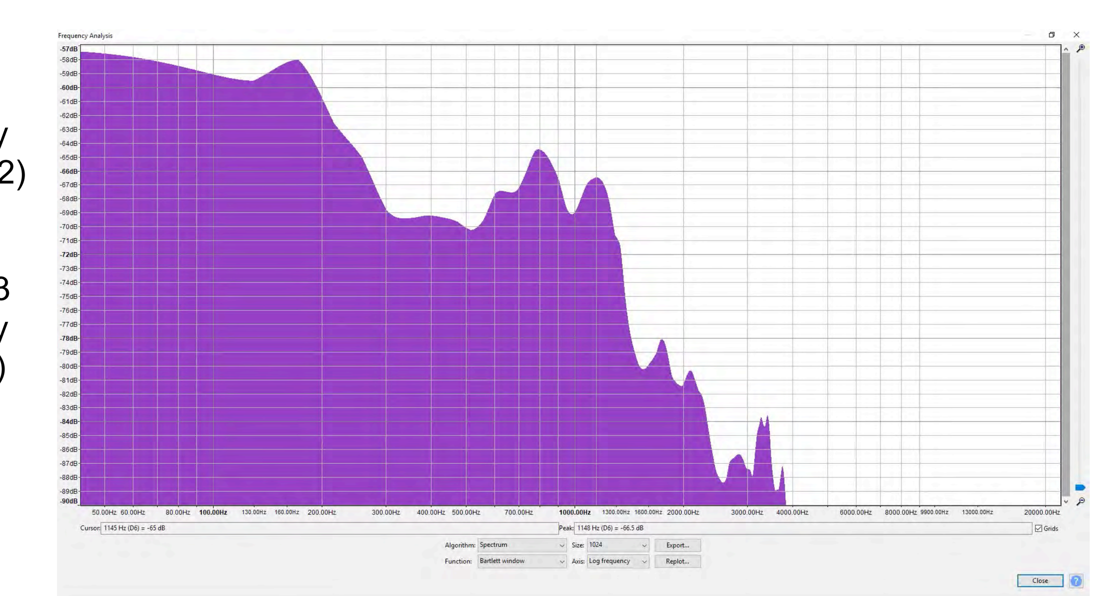
True Experiment (Sound in the Upper Atmosphere)

The data that indicated sound in the upper atmosphere becomes quieter as altitude increases, meaning the amplitude of the recorded sound waves became smaller. The frequencies of the noise maker remained mostly the same with only slight variations, however the higher frequencies overall decreased as a whole. Despite turning off unexpectedly shortly after the balloon popped, our sound program accurately measured what it needed to for the majority of the ascent. Our experiment was a success and our hypothesis was confirmed: the frequencies and amplitude (loudness) of sound waves decreases as altitude increases.

A change in the intensity of sound waves (amplitude) is directly correlated to a change in dB SPL or dBFS. dB SPL is measured with this formula: 20 * log(dB start / dB end).

Lowest frequencies:
20 * log(-57/-72) = -2.029
The sound waves' intensity got about twice as small (-2)

Noise maker:
20 * log(-66.5/-88) = -2.433
The sound waves' intensity got 2.4 times smaller (-2.4)



Future Direction

Field Experiment Optimization:
To better optimize our field experiment, we could get a new temperature sensor that has the ability to read the extreme temperatures found in near space. We could also repeat the experiment multiple times to further support our findings.

True Experiment Optimization:
To better optimize our true experiment, we would have two microphones to capture sound: one on the outside of the module, and the other on the inside. The microphones would also need to be capable of running their programming outside of the module in the extremely cold temperatures found in near space, as well as have an extremely durable way to support the microphone during the ascent and descent of the module. Also, no other groups noise makers would be present in the experiment that could possibly interfere with our findings.

Acknowledgements

Dr. Seth Shafer (Music Technology professor at College of Music), Dr. Derrick Nero, Partner group: Sierra Rasmussen, Kiera Carlson, Hannah Sheppard, and Betsy Rosales
Weather model image from: https://2012books.lardbucket.org/books/principles-of-general-chemistry-v1.0/s07-06-chemical-reactions-in-the-atmo.html.

University of Nebraska Omaha

UNIVERSITY OF NEBRASKA AT OMAHA

Sound in Space

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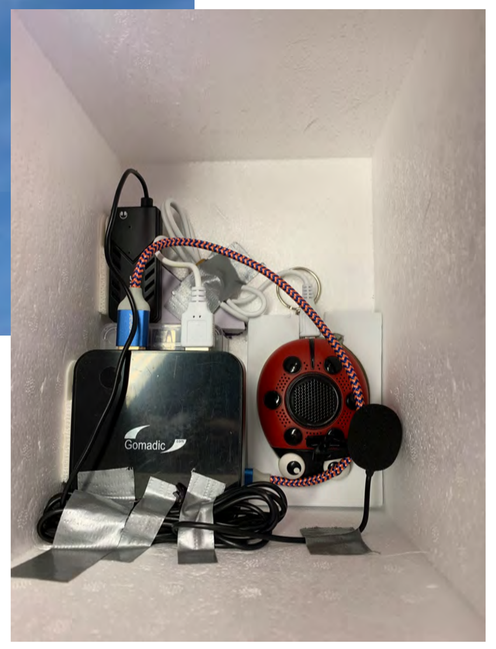
Introduction

For our NSE, we decided to test the theory of, non-existence of sound in space. In order to test this theory, we designed a true and quasi experiment that incorporated sound in each. We used two sound modules, one on the inside of the HAB module and one on the outside of the HAB module. For the true experiment, we used sound module #1 which was an emergency personal alarm (shaped as a ladybug). This was placed on the inside of the box and was very audible and easy to hear. The purpose for the true experiment was to see if a sound module in a controlled climate would produce sound inside the styrofoam HAB module as it ascended into near space. As for the quasi/field experiment we used sound module #2 which was a set of 8 bells. These were placed on the bottom of the box all attached in pairs of 2's. The purpose of this quasi experiment was to see if a sound module in an uncontrolled environment could produce sound outside of a styrofoam HAB module as it ascended into near space.

Design

Variables
- True Experiment Variables:
  - Independent: temperature inside HAB module, altitude, pressure
  - Dependent: Sound module #1 (ladybug)
  - Constraints: couldn't test negative temperatures for sound module
- Quasi Experiment Variables:
  - Independent: weather factors, altitude, pressure, temperature, wind speed
  - Dependent: sound module #2 (bells)
  - Constraints: lack of movement of the box

Procedures
- Build module
- Begin recording on Audacity
- Launch Module
- Retrieve Module
- Data Analysis
- Conclusion



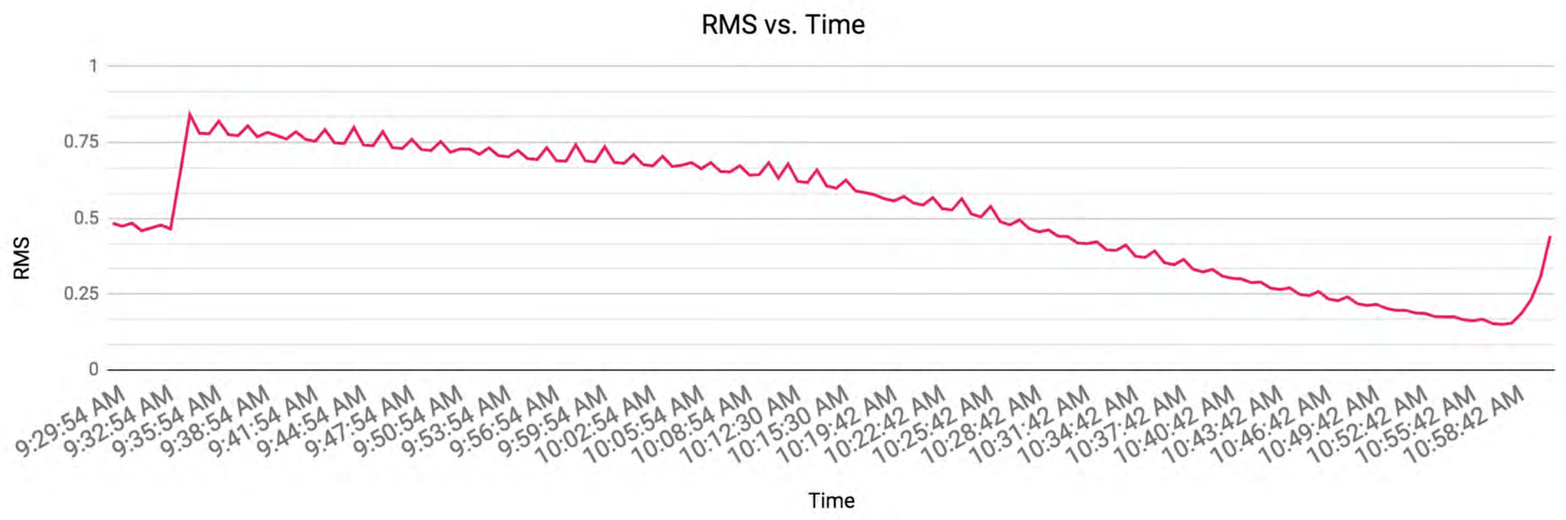
Materials List
- Styrofoam HAB module
- Gomadic lithium battery
- HDMI cord
- Sound generator (ladybug alarm)
- Fifine microphone
- Charging cable for sound generator
- Raspberry Pi
- Bells

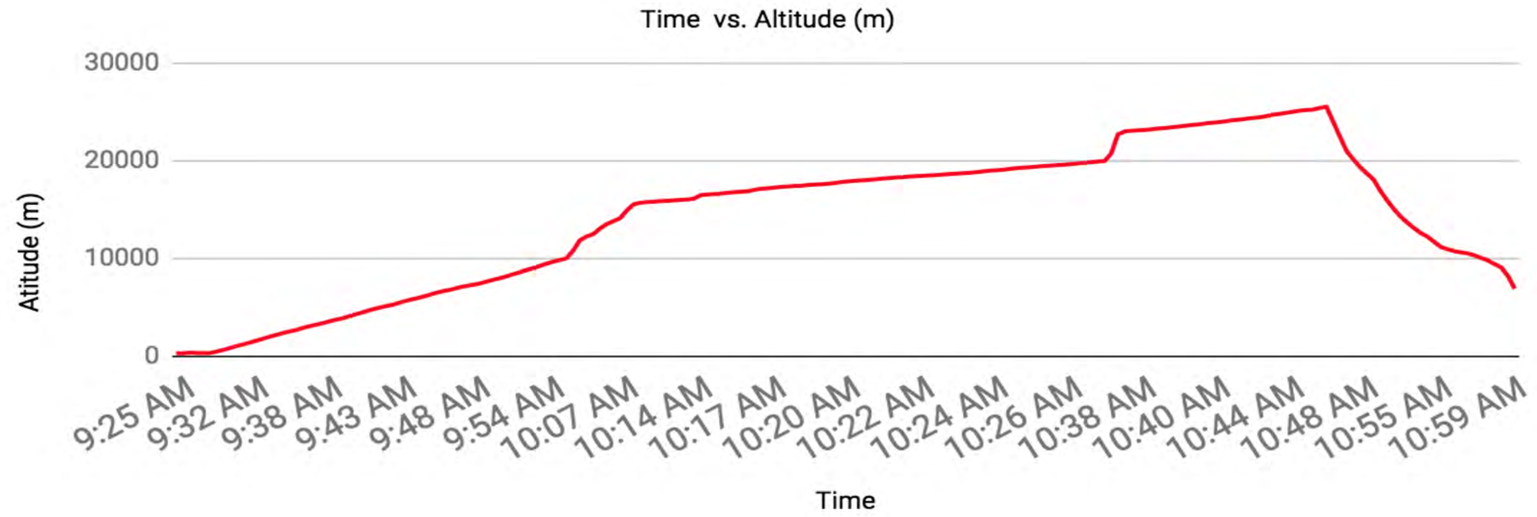
Research Questions/Hypotheses

This true experiment is to test if the sound module #1, the emergency personal alarm, will continue to produce sound inside the styrofoam HAB module as it ascends into near space. We think as the styrofoam HAB module increases in elevation the sound from the sound module #1, the emergency personal alarm, located inside of the box, will slowly fade/decrease in volume, but not completely disappear.

This quasi-experiment is to test if the sound module #2, the bells, duct taped on the outside bottom of the styrofoam HAB module will continue to produce sound with other frequencies occurring as it ascends into near space. We think as the styrofoam HAB module increases in elevation the sound from the sound module #2, the bells, located on the outside of the module will completely disappear or become silent.

Results/Findings





- RMS- average of values over a period of time (amplitude)
- Launch occurred around 9:30 am
- Rapid increase of RMS values at launch, steady decrease until pop of weather balloon at approximately 10:45 am
- Altitude increased throughout flight until pop of balloon at 10:45 am in which module gradually decreased in altitude until landing
- As module increased in altitude RMS valued decreased
- Sound sources at higher altitudes emitted less power due to decrease in pressure

Conclusions

- Found true experiment sound module to be a success
- Found quasi experiment sound module to be a success
- Data collected in form of numbers (RMS) instead of an audio recording, which was an error
- Unable to differentiate between true and quasi data
- The higher the altitude of the balloon, the weaker the sound
- True hypothesis conclusive
- Quasi hypothesis inconclusive
- Aside from the data failure NSE overall success
- NSE resulted in knowing that as our styrofoam HAB module ascended into near space sound did fade the higher the altitude, but still existed

Future Direction

- Further research of program Audacity
- Create time frame for Audacity to record and automatically save audio file
- Choose alternate sound generator for quasi-experiment
- Have monitor readily available after recovery

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UNIVERSITY OF NEBRASKA AT OMAHA

Space-Bound STEMs

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Introduction

In order to understand how carnation cells would be affected by a near-space environment we had to research how they function in normal conditions. The cells in the stems are called xylem. Xylem transports the water from the stem into the petals (“Microscopy - Looking at xylem and specialised cells,” 2018). To understand how they function we performed a dye experiment, following the procedure from “Investigating transport systems in a flowering plant,” (2011). After this we looked for studies done in space on plants. NASA has done studies of plant growth in space because it’s becoming vital with longer space missions becoming more of a possibility. Long-term space exploration will require astronauts to be able to grow their own food in space. Beyond food, plants can also recycle carbon dioxide into oxygen, a trait that would serve space colonies well, for obvious reasons. (Dunbar, 2013).

Design

Variables

	True Experiment:	Quasi Experiment:
Controlled	• Location	• Location
Independent	• Temperature	• Environment
Dependent	• Cell Damage	• Cell Damage

Procedures

Assembling and Launching:
- Humiture sensor activation
- Carnation placement

After Retrieval Cell study:
- Determine cell damage to the xylem

After Retrieval Dye Experiment:
- Test absorption rate through dye experiment

Materials List

True Experiment
- Raspberry Pi Starter Kit
- Sunfounder 37 kit
- Battery
- Power supply
- Humiture sensor

Quasi Experiment
- Cutting board
- Scalpel
- Tweezers
- Water dropper
- Microscope slides
- Cover slip
- Microscope

Both Experiments
- 3 carnations (white)
- Camera
- Water
- Blue food dye
- Test tubes, one for each carnation (3)
- Test tube holder

Research Questions/Hypotheses

This true experiment is to measure the way temperature affects the carnation cell condition in the stem. We hypothesize the carnation will have cell damage and the dye won’t absorb as much as the control carnation.

This quasi experiment is to put carnations into a near space environment, and determine how the cells are affected. We hypothesize the carnation will have cell damage and the dye won’t absorb at all.

Results/Findings

Carnation Xylem Cells
(at 10x magnification)

Control — True (inside of module) — Quasi (outside of module)

Carnation Dye Experiment

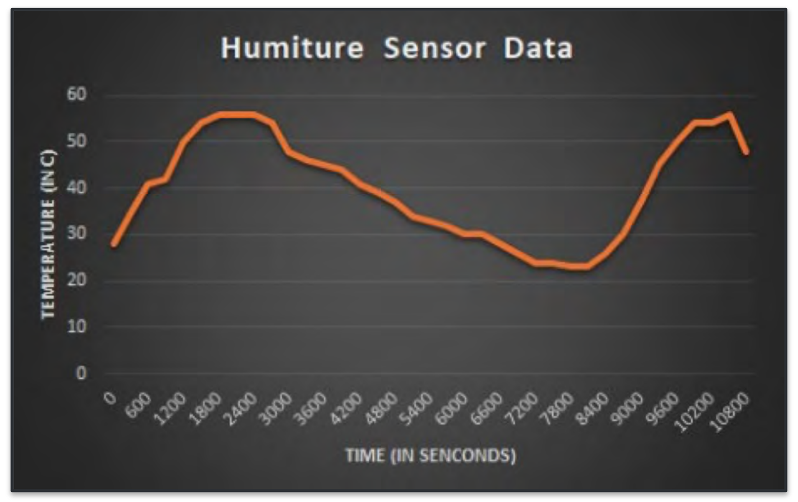
Start of dye experiment — 4 hours into dye experiment — End of dye experiment (24 hours)

Carnation Dye Experiment

Dye mixture (ml)	Control	True (inside)	Quasi (outside)
Initial	15 ml	15 ml	15 ml
Leftover (after 24 hrs)	9 ml	10 ml	12 ml
Absorbed	6 ml	5 ml	3 ml

Humiture Sensor Data

Sec 0: temp.	28°C	Sec 5400: temp.	33°C
Sec 300: temp.	35°C	Sec 5700: temp.	32°C
Sec 600: temp.	41°C	Sec 6000: temp.	30°C
Sec 900: temp.	42°C	Sec 6300: temp.	30°C
Sec 1200: temp.	50°C	Sec 6600: temp.	28°C
Sec 1500: temp.	54°C	Sec 6900: temp.	26°C
Sec 1800: temp.	56°C	Sec 7200: temp.	24°C
Sec 2100: temp.	56°C	Sec 7500: temp.	24°C
Sec 2400: temp.	56°C	Sec 7800: temp.	23°C
Sec 2700: temp.	54°C	Sec 8100: temp.	23°C
Sec 3000: temp.	48°C	Sec 8400: temp.	26°C
Sec 3300: temp.	46°C	Sec 8700: temp.	30°C
Sec 3600: temp.	45°C	Sec 9000: temp.	37°C
Sec 3900: temp.	44°C	Sec 9300: temp.	45°C
Sec 4200: temp.	41°C	Sec 9600: temp.	50°C
Sec 4500: temp.	39°C	Sec 9900: temp.	54°C
Sec 4800: temp.	37°C	Sec 10200: temp.	54°C
Sec 5100: temp.	34°C	Sec 10500: temp.	56°C
		Sec 10800: temp.	48°C



Conclusions

Most of our experiment was a success, however, after looking at the data, we discovered the inside of our module wasn’t consistent with the temperatures associated with a near-space environment, which are frigid (the module temperature range was 23°–57°C.) This was likely affected by the other group using hand warmers, which we didn’t believe would be warm enough to affect our data. While this wasn’t what we anticipated we can still make observations of how temperature affects the carnations. Our cells had little visual differences, however, we know there was damage to the xylem cells because of the dye experiment. Our true hypothesis was correct, temperature change caused cell damage and the carnation absorbed less of the dye mixture than our control carnation. Our quasi experiment was partially correct. There was cell damage, however, the carnation was still able to absorb the dye mixture, although at a reduced rate.

A failure of our NSE was related to the humiture sensor data. The original programming worked well for viewing in real time, however it wasn’t ideal for an extended time. Due to the size of our recorded humiture data, we had to condense it considerably. We could avoid this in the future by having the sensor take readings at farther-apart intervals, and enabling timestamp recording.

As stated in the introduction, studying plant growth in space is vital. Plants are also correlated to greater mental health, especially in particularly isolating environments, such as space. (Dunbar, 2013).

A real world application for the high temperatures (57°C) relates to climate change. Carnations are a food source for honeybees, which are a crucial part of modern farm success. According to the American Beekeeping Federation, “As honey bees gather pollen and nectar for their survival, they pollinate crops such as apples, cranberries, melons and broccoli. Some crops, including blueberries and cherries, are 90-percent dependent on honey bee pollination. One crop, almonds, depends entirely on the honey bee for pollination at bloom time.” (2018). With this in mind, knowing how higher temperatures affects carnations is vital to honey bee survival, which in turn, is vital to the survival of human beings.

Future Direction

Taking a computer science class could help us better understand how programming works as well as gain more experience in coding, increasing our functionality and productivity. Feasibility would decrease due to time and cost.

Testing without hand warmers would keep the feasibility the same, while increasing our functionality by giving more accurate temperature readings of a near-space environment. Productivity would likely stay the same.

Using carnations that are still growing in soil, we could further explore direct applications of temperature and a near-space environment on carnation cells. This would hinder feasibility due to time and cost of growing the carnations. Functionality as well as productivity would increase by giving us deeper insights into how temperature and a near-space environment affect plants growing in these conditions.

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