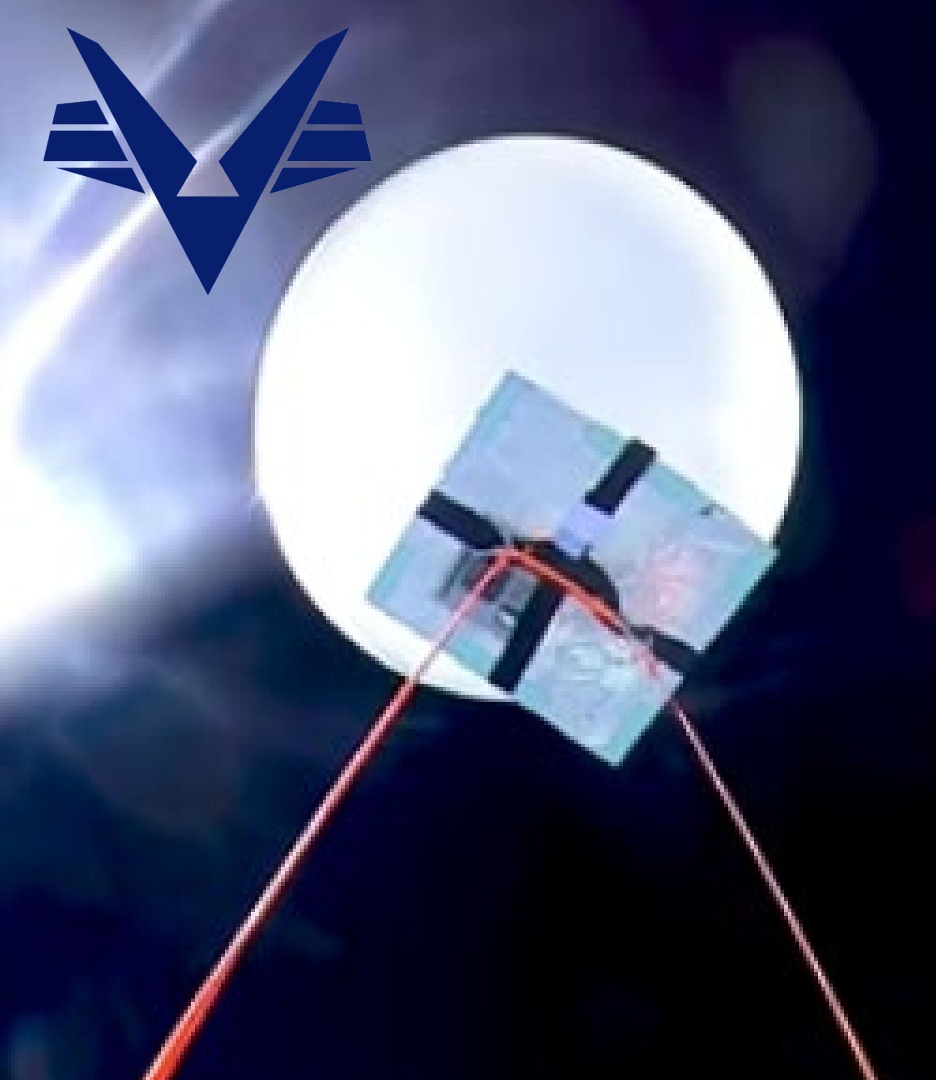

CIVIL AIR PATROL
U.S. AIR FORCE AUXILIARY



Civil Air Patrol

presents

the

2023

<u>National AE</u>

<u>High-Altitude</u>

<u>Balloon Challenge</u>

Awards Program

Capt Bob Roberts, SC Wing

HABC Program Director
and
National AE Programs Lead

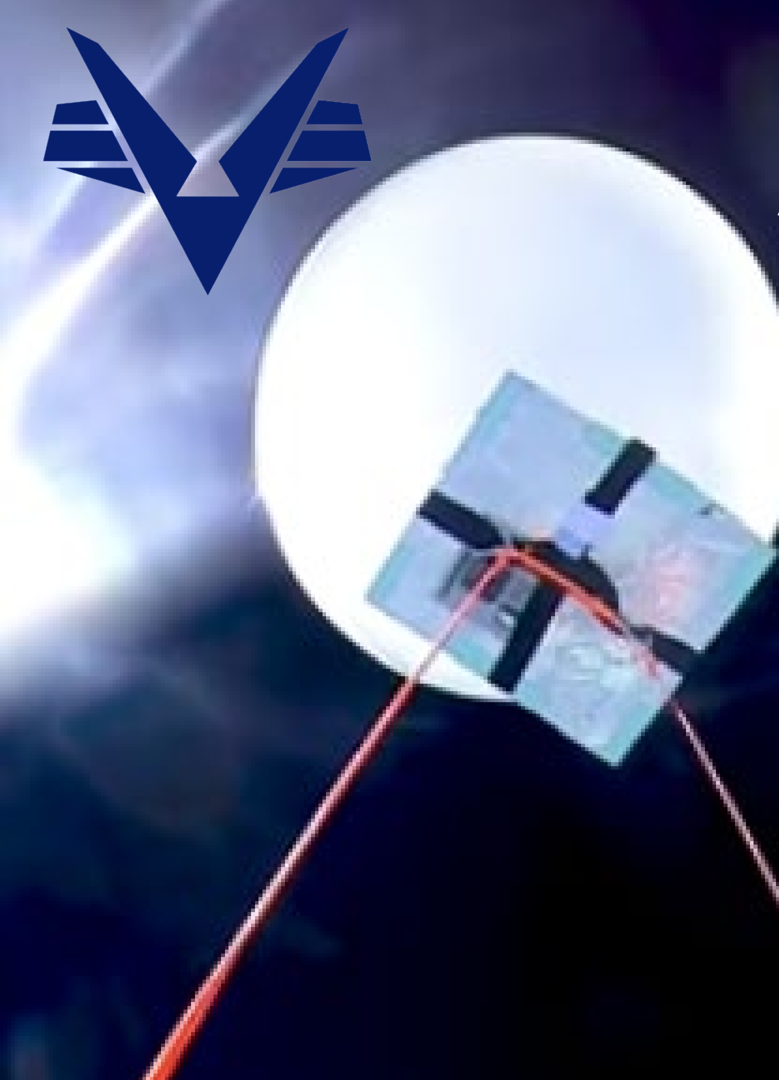
***HAB Awards Program on his
AE YouTube Channel

Major General
Ed Phelka
CAP National Commander

Welcome and Appreciation

Special thanks to the HABC team:

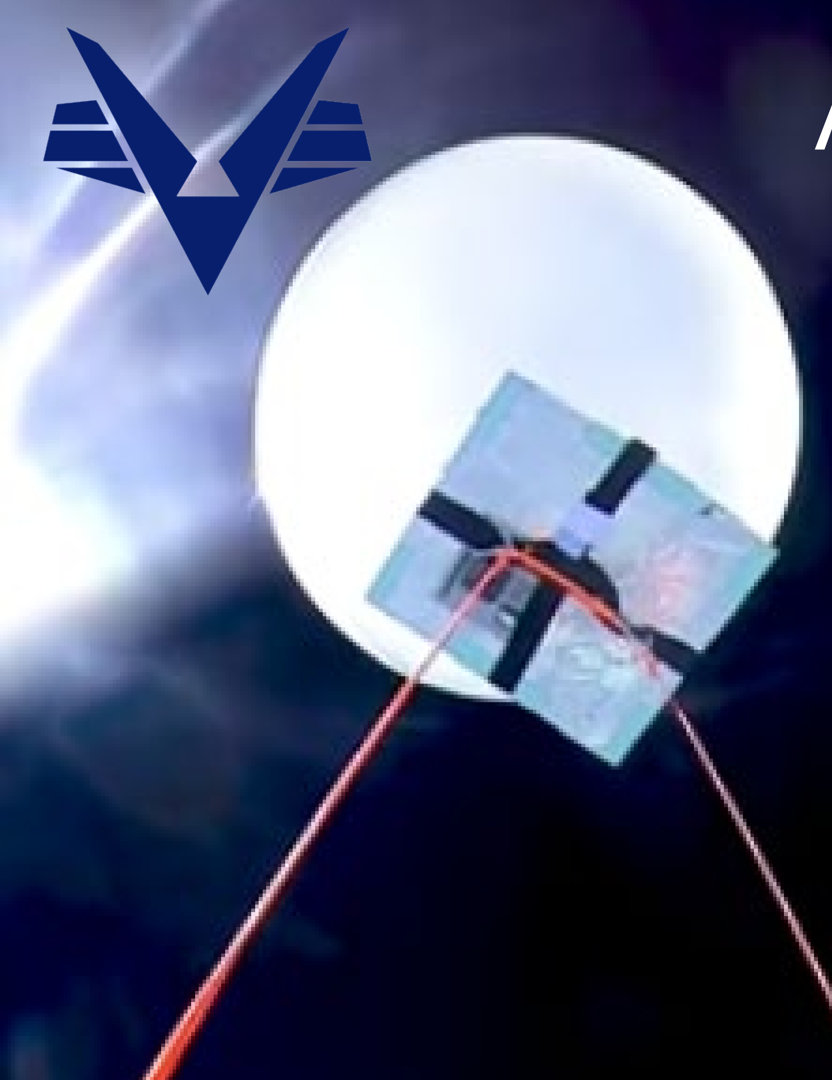
Col Aaron Angelini, INWG CC
(and INWG SAREX Team)
Lt Col Karen Cooper, NER DCS/AE
Maj Julie Sicks-Panus, NHWG DAE
Lt Michael Dean, GLR-IN-803 Commander
Lt Michael Austin, GLR-IN-803 AEO



And, from CAP National HQ:

Dr. Shayla Broadway
Interim Director, AE

Susan Mallett
Education Outreach Coordinator



Awards Announcements

If any team expected to win in one or more categories and did not do so, consider these possible reasons:

1- There were many excellent entries in each category with only 1-2 scoring points separating the winning entries, and the team's score just did not make the top.

2- The team failed to include one or more items listed on the very specific scoring rubrics provided as expectations and guidance for each category.

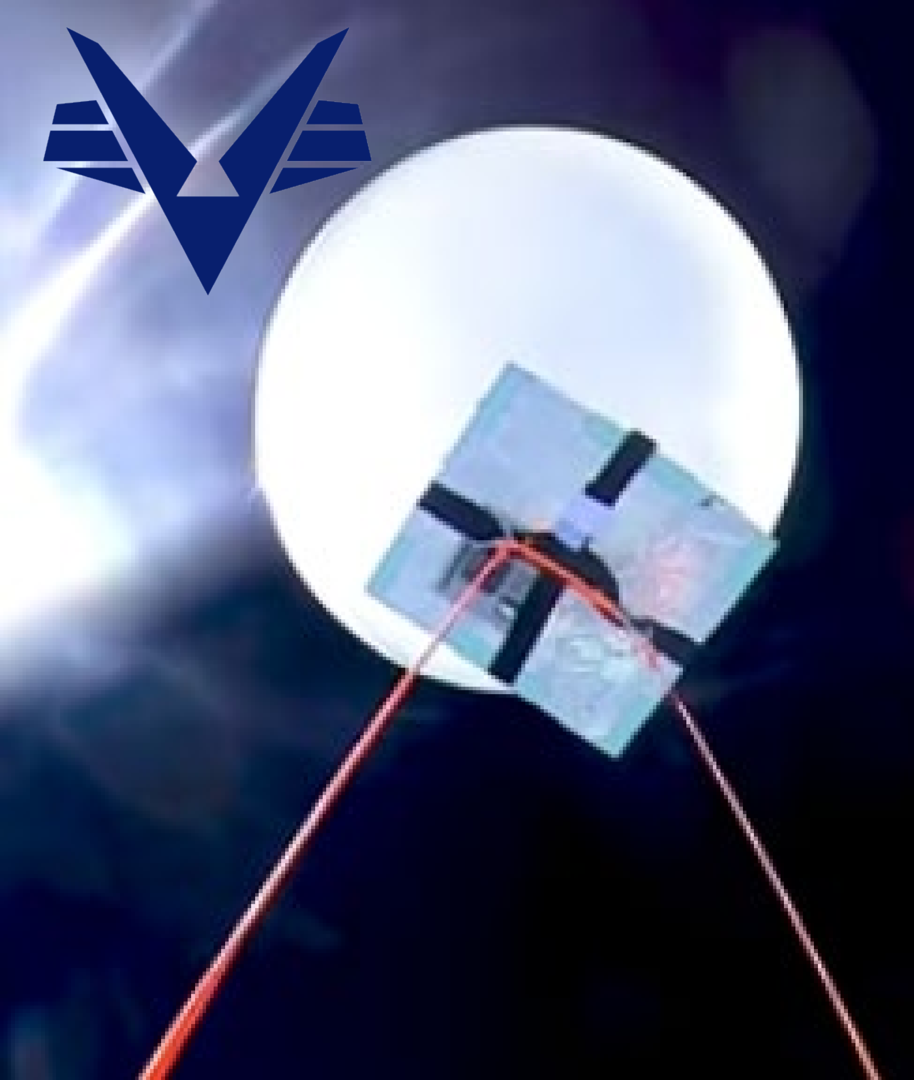
AFA Award Grants

The Air & Space Forces Association (AFA) provides award grants for the top three units in each submission category.

With gratitude to the AFA, winners will be able to conduct more STEM projects in the coming year.

AFA
Aerospace Education Programs

Congratulations to the following award winners!



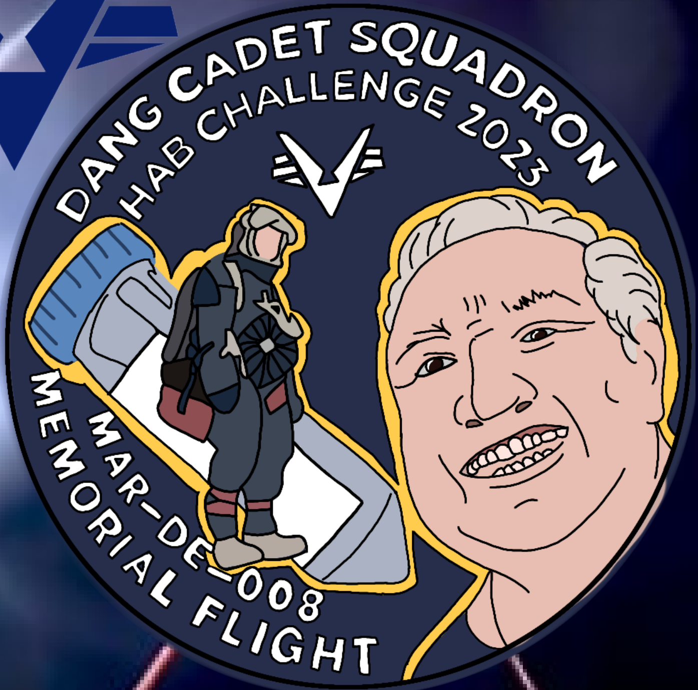
Hand-drawn Mission Patches

Note: The description submitted for each patch was a big part of the patch selection.

Hand-drawn Mission Patch Finalists: $150 Grants

PCR-CA-414
San Francisco Cadet
Squadron 86

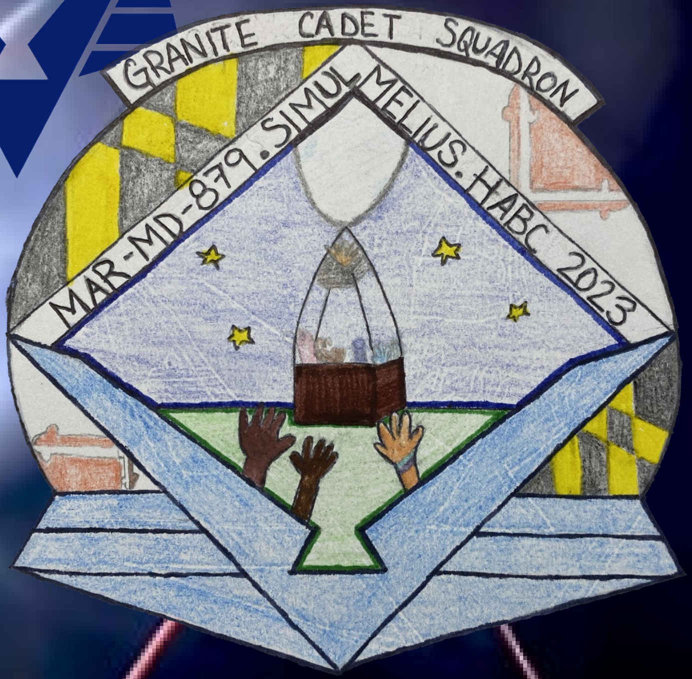
NER-NY-311 9th Suffolk
Cadet Squadron



MAR-DE-008
Delaware Air National Guard
Cadet Squadron

Hand-drawn
2023
Memorial
Kittinger Patch
“One-Time
Extra Winner”

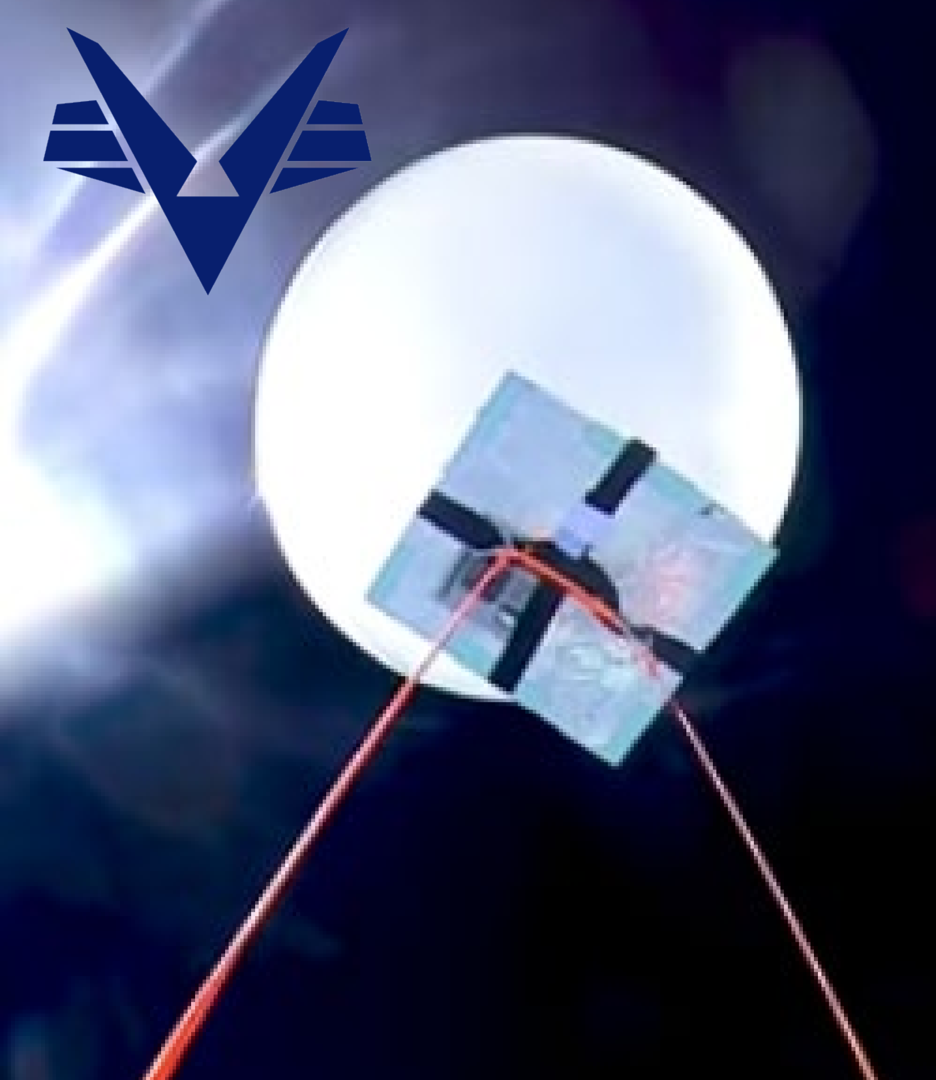
$150 Grant



MAR-MD-879
Granite Cadet Squadron

Hand-drawn
Mission Patch
Winner "Unity,"
Simul Melius:
Better Together

$200 Grant
& Placement on
2023 Certificate



Digitally-drawn Mission Patches

Note: The description submitted for each patch was a big part of the patch selection.

Digitally-drawn Mission Patch Finalists: $150 Grants

MAR-DE-025
Middletown Cadet
Squadron

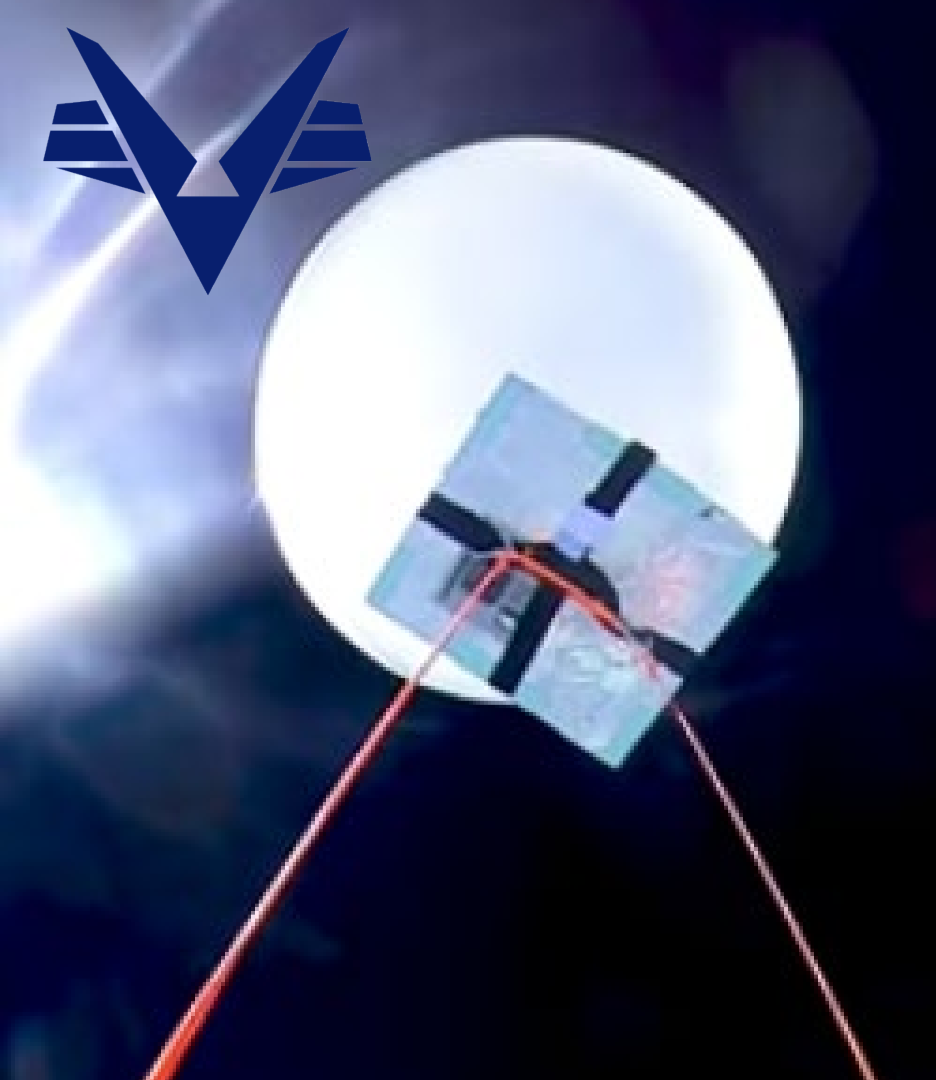
NER-NJ-073
Curtiss Wright
Composite Squadron

Hand-drawn
then digitally
finished

Digitally-drawn
Mission Patch
Winner
"CAP Logo Wings
Lifting the HAB"

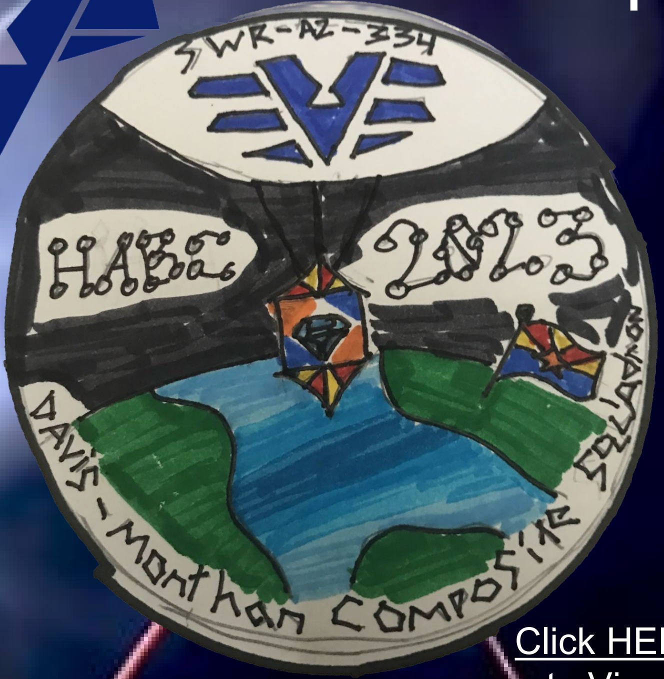
$200 Grant
& Placement on
2023 Certificate

PCR-CA-240 Santa Barbara
Composite Squadron 131



Pre-launch Videos

Pre-launch Video Finalists: $150 Grants

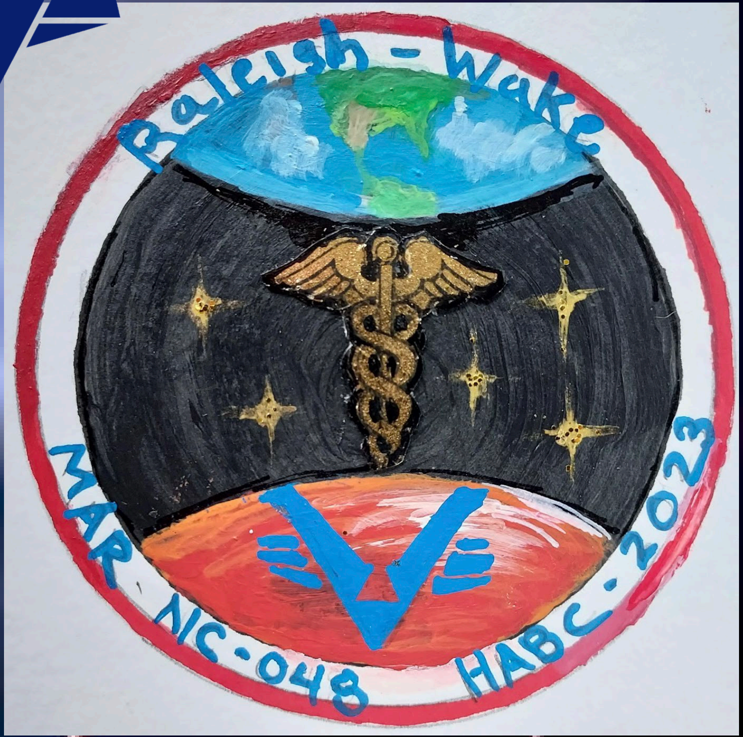


Click HERE to View.

SWR-AZ-334
Davis-Monthan Composite Squadron

Click HERE to View.

NER-NY-022 Buffalo Composite Squadron



Pre-launch
Video Winner:
$200 Grant

Click HERE
to View.

MAR-NC-048
Raleigh-Wake Composite Squadron

Science Experiment Reports

With the experiment research, results, and relevance to future space exploration

RMR-ID-015 NAMPA COMPOSITE SQUADRON, CIVIL AIR PATROL

A DEMONSTRATION OF ORIENTATION TRACKING

To better understand the capabilities of a self-maneuvering balloon

C/2d Lt Jonas Parsons
C/Capt Miguel Snell

CIVIL AIR PATROL

1: BACKGROUND

On February 3rd 2023, a balloon originating from China entered US Airspace (Voa news, 2023). This balloon was equipped with surveillance technology capable of capturing highly detailed ground imagery. What made this balloon undoubtably advanced was its capability to navigate using propellers and a rudder. (Voa news 2023) This unique maneuvering ability poses a significant national security risk. In order for our nation to protect itself from similar threats, we need to understand the technology behind them.

The primary objective of this project is to showcase how the software within such a machine could collect the orientation data needed for calculating the maneurvers of such a balloon autonomously. using gyroscopic and altimeter data. Understanding the methodology behind collecting this data and its usage is pivotal in grasping the capabilities similar threats. This project hopes to underscore the value of reverse engineering, illustrating how it can aid in unraveling the potential security risks we are facing as a nation today

2: HYPOTHESIS

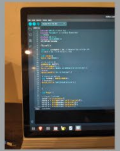
The surveillance balloon spotted over the United States did not have a pilot and was not remotely controlled. It had the ability to navigate itself and control direction. Therefore it must have been able to perceive, detect, and gauge its own bearing. Our hypothesis is that Orientation data useful for making calculations to maneuver can be gathered using a gyroscope and altimeter. This would explain the balloon's ability to collect and use data.

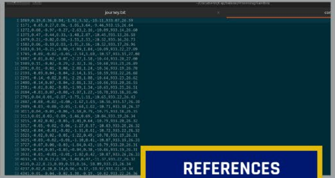
3: MATERIALS

- Arduino
- BMP180
- MPU6050
- 3.7 380mah Lipo
- SD read/writer
- 32 gb sd card

4: TESTING METHOD

- An Arduino pro mini 3v was outfitted with a MPU6050 and a BMP180 connected over I2C.
- An SD card reader/writer was connected via SPI.
- The Arduino was powered with a 3.7v 380mah Lipo Battery.
- The Arduino ran a code that collected data every 100ms [1]
- The data consisted of gyroscopic and acceleration data from the MPU6050, as well as pressure and temperature data from the BMP180.
- The data was then written to the SD card.
- The data was uploaded and analyzed





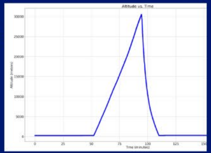
5: RESULTS

The Following is an equation for altitude calculation, where data points are inputted for the variables.

- h = altitude in meters
- P = pressure at altitude (hPa)
- P0= 1014 Reference Pressure (hPa)
- R = 8.314 Universal gas constant (J/(mol*K))
- T = Temperature at altitude (kelvin)
- M = 0.0289644 Molar mass of dry air (kg/mol)
- g = 9.80665 Acceleration due to gravity (m/s^2)

$$h = \frac{-\ln\left(\frac{P}{P_0}\right)RT}{Mg}$$

We then calibrated the result based upon an apogee of 30577m, and a starting altitude of 270m. There is 2 added calibration variables, f = 1.2, F = 50. Based upon (to the right) equation, the following graph was able to be plotted using matplotlib:

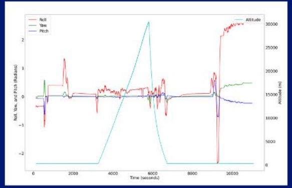


Gravity Vector Calculation

Using the x,y, and z acceleration values from the gyroscope a vector pointing towards gravity was able to be created. These equation were used:

The gravity vector was able to be calibrated by combining the three degrees of freedom which were calculated by finding the arc tangent of the 2 acceleration values corresponding to each degree of freedom. The values are in Radians,

$$yaw = \tan^{-1}\left(\frac{x}{z}\right) + Sign(z)\frac{\pi}{2}$$

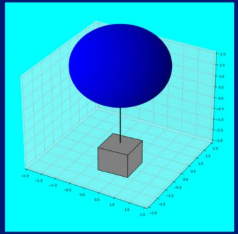


Orientation Relative to Gravity

After the roll, pitch and yaw values that that pointed to gravity were calculated, a point on the graph was picked to act as a calibration point. The rest of the values were then calibrated of this point to get the orientation of the balloon.

Visualizing Orientation

We created an animation that paints an image of what the balloon would do with all of the above data applied. In the animation, data about its orientation is inputted from the created dataset.



6: ANALYSIS

With the date we collected from our own equipment, and a simulation we ran using a responsive animation, we found that a balloon using this method could accurately obtain orientation data, and use it to control its direction. Another things we noticed form our data was how surprisingly stable the balloon was.

7: IMPLICATIONS/CONCLUSION

We tried having the data be collected every 100ms, but it ended up not serving a valuable purpose, and really just drained the battery life of our equipment. Relevant to that, a longer-lasting batter would help us not have to worry about things dying when were trying to collect data, no matter how often. Another thing we found is that the vertical axis on the gyro is not very reliable. In the future, having a magnetometer would help improve directional orientation. On that note, a GPS would allow for position tracking, which would help us better understand the movements of the balloon and how it changes.

This experiment showcased several facts that help us understand how threats like surveillance balloons remain a serious threat. The gyroscopic data was useful for seeing how stable the balloon is, proving that a sufficiently advanced balloon would not need an ultra-advanced setup to remain stable. The balloon that penetrated US airspace was able to utilize gyroscopic technology to be aware of and maintain its upright position, as well as control pitch. In order to get information about the steering ability we would need to supplement our data with a magnetometer for direction. This Information implies that foreign equipment and flying machines have the capability to autonomously navigate and control their direction of flight thousands of miles away from their origins, proving that such mechanism, or balloons in this case, could be used as weapons of war against the United States. If that is true, all available date should be used to best understand this risk and construct ways to defend against it.

REFERENCES

- Voa news. The US-Chinese balloon is part of a large spy program. 2023; https://learningenglish.voanews.com/a/us-chinese-balloon-is-part-of-large-spying-program/6953672.html
- Ellgen, Paul. The Barometric Formula. 2022; https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Thermodynamics_and_Chemical_Equilibrium_(Ellgen)/02%3A_Gas_Laws/2.11%3A_The_Barometric_Formula

HIGH ALTITUDE BALLOON CHALLENGE 2023

$250 Science Experiment Report Finalist: RMR-ID-015 Nampa Composite Squadron

How is Photographic Film Affected by High Altitudes?

NCR-MN-116, Saint Cloud Composite Squadron, Saint Cloud, MN

Launch Date- 8/5/2023

Balloon A Burst Altitude- 100,325

Hypothesis-
The radiation found in space will make photos taken from a disposable camera brighter

Background/ Research-
The environment of space would ruin most electronic devices and would make it hard to get personal photos, so if we do not have those means of taking photos do our old ways of taking photos still work, using film. The way film works is it takes the negative of the light coming in so if white light is coming in then the film gets darker. Then when it is developed, the photo is positive. So, the colors are normal. Radiation is a type of light. With sound there are sounds we can't hear. It is the same with light and radiation, it is a type of light we cannot see. This means that radiation should have the same effects on film as light.

Materials-
-Fuji film Quick Snap flash, disposable camera
-Test tube

Testing Method-
Our method of testing was to take pictures of random items with disposable cameras then we removed the film, sent one up to space and left the other one on earth. When it came back, we got it developed and then examined them.

Results-
Our experiment is more to answer the yes or no question of does radiation influence film and we measured this by examining and comparing the two samples of each photo. We did notice at least a slight change in all the photos, the last one had a brighter coloration in the lighting department.

Conclusions-
Our experiment proved that radiation does influence film, making it brighter in the final product. We were expecting the radiation to completely ruin the film. It was not that dramatic of a change, and it was hard to see the change for most of the photos. In the last photo the difference was most prominent. We attribute this to the fact that as the film winds up in the canister it would be on the outside and have the most exposure to the radiation. What we found in our experiment really leads to some further exploration on the effects of long periods of exposure of film to radiation. A mistake we did make is to take almost 100% of our photos outside. This made it hard to compare the photos and find differences because they were already bright. If we redid this experiment, we would take the photos in varying amounts of light so that we can better gauge the difference between the control and the flight film.

Implications-
We discovered that radiation does affect film. This means that both electronic ways of taking photos (phones, etc.) and the traditional means of taking photos(film) are not going to work for people to capture personal photos in space.

Control | Flight

References-
ScienceDirect, Photographic Film, https://www.sciencedirect.com/topics/earth-and-planetary-sciences/photographic-film
Quora, What happens to photographic film when exposed to radiation? https://www.quora.com/What-happens-to-photographic-film-when-exposed-to-radiation

$250 Science Experiment Report Finalist: NCR-MN-116 Saint Cloud Composite Squadron

$350 Science Experiment Report Winner: SER-FL-447 Clearwater Composite Squadron

CIVIL AIR PATROL

The Effects of High Altitudes on Coffee Beans

Clearwater Composite Squadron SER-FL-447

Background

With the current advancements in space technology, tourism outside of our atmosphere is just around the corner. But with this commercialized space travel will come new challenges, including the transportation and management of resources, especially agricultural products. Thus, we chose coffee beans as a popular ingredient to send in the high-altitude balloon and measure the effects of the exposure to these extremes.

Hypothesis

We hypothesized that with the exposure to high altitude, the coffee beans would become weaker and less dense due to the radiation and pressure loss.

Methods & Materials

To calculate density, we used a graduated cylinder to measure water displacement and a scale to measure mass, then inserted that information into the appropriate formula, d = m/v. For pH, equal amounts of coffee beans were ground using a mortar and pestle and brewed using a hot plate and distilled water, after which a pH meter was used. The specific mass measurement was recorded using a vial and an electronic meter scale. Hardness was measured with a hardness meter on five individual beans for each sample, which were then averaged. Color was measured by comparing the coffee beans to paint samples, but there was no visual difference between the control and experimental samples.

Procedures

During the testing, we wore gloves and ensured overall cleanliness and safety within the testing area. We collected the data in a Google Sheets document.

Results

Though the mass and color remained unaffected, the volume, density, and hardness increased very slightly from control to flight, while the total displacement and pH decreased.

Overall, changes were minimal on average, and held some inaccuracies due to experimental error.

CONTROL

	Vial Mass (g)	Mass (g)	Volume w/o Bean	Volume w/ Bean	Total Displacement	Density	pH	Hardness
Data	35.2 g	0.4 g	20 mL	21 mL	20 mL	0.02	5.8	94

FLIGHT

	Vial Mass (g)	Mass (g)	Volume w/o Bean	Volume w/ Bean	Total Displacement	Density	pH	Hardness
Data	35.2 g	1.0 g	20 mL	22 mL	19 mL	0.05	5.3	95

Data Analysis

In our results, it can be shown that there was an increase in hardness. We believe this to be because of less weight from the atmosphere, as well as Amonton's law. With the maximum altitude of the HAB Challenge being somewhere around 90,000 ft, that would put our beans in the stratosphere.

Assuming that the air in the stratosphere has a constant volume, then the pressure is directly proportionate to its absolute temperature. As the stratosphere is around -50 C, the absolute temperature would be 223.15 K. This means that the surrounding atmosphere would have a pressure of 56.7 kPa. We therefore infer through Henry's law that the bean's trapped air pressure was higher than the ambient pressure and was able to be released along with some oils. This caused the bean to be harder and more acidic.

In summary, according to Amonton's and Henry's Laws, the lower temperature and less atmospheric weight causes the atmosphere to have a much lower ambient pressure than that of the pressure inside the beans, causing gas to escape, increasing hardness, and lowering PH.

Conclusion

Our hypothesis was correct in that the volume, density, and hardness increased due to the decrease in pressure, though in the realm of displacement and pH we were incorrect, as those values decreased. We are unsure if radiation was a factor in this.

Impact & Improvements

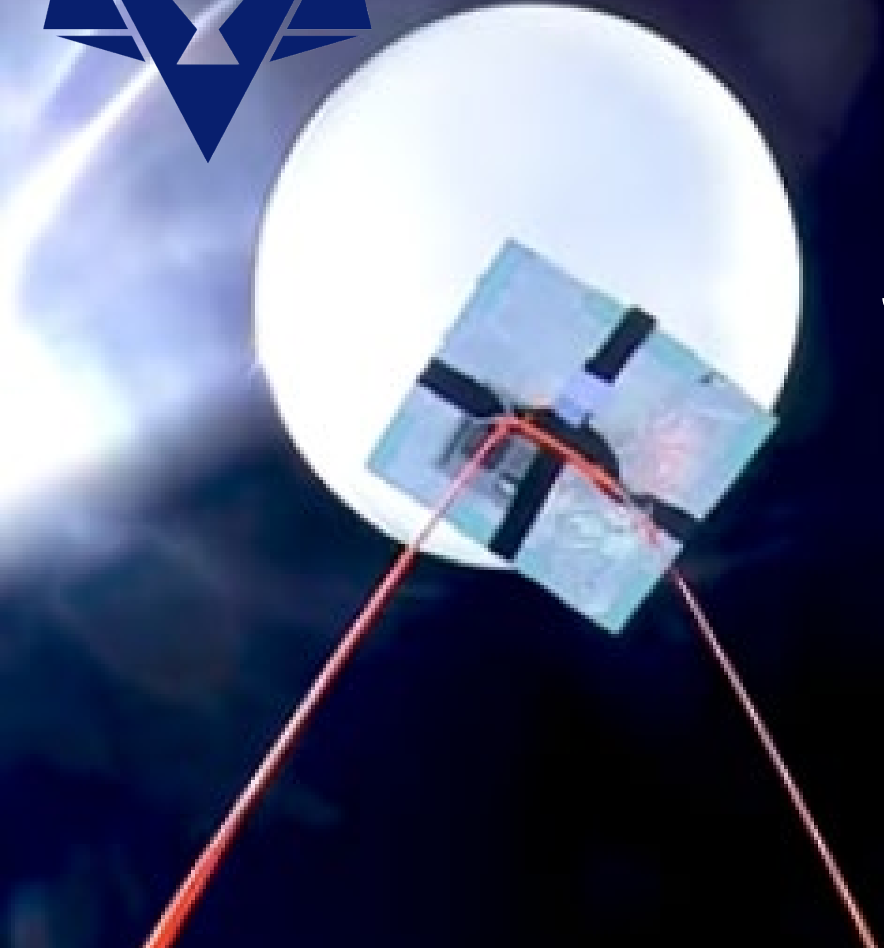
The data provided in results resides in the margin of error due to the uniqueness of each individual coffee bean (leading to variable data collection) and a possible lack of sufficient trials. Though the variability of the beans is something we cannot change, by utilizing more trials and adding that to our data we will likely get more accurate test results.

References

- Avishay, Dor M. and Kevin M. Tenny. Henry's Law. 29 January 2023. Web. 1 October 2023. <https://www.ncbi.nlm.nih.gov/books/NBK544301/>.
- Sullivan, Randy. Amonton's Law. 2012. Web. 1 October 2023. <https://chemdemos.uoregon.edu/demos/Amontons-Law#>.
- VanCleave, Janice. Temperature Changes Within Earth's Atmosphere. n.d. Web. 1 October 2023. <https://scienceprojectideasforkids.com/altitude-vs-temperature-change/>.

Documentary Videos

Shares HAB Challenge info from beginning to end with plan if Kittinger Cup and cash prize was won



Documentary Video Finalists: $250 Grants

Click HERE to View

NER-MA-007
Goddard Cadet Squadron

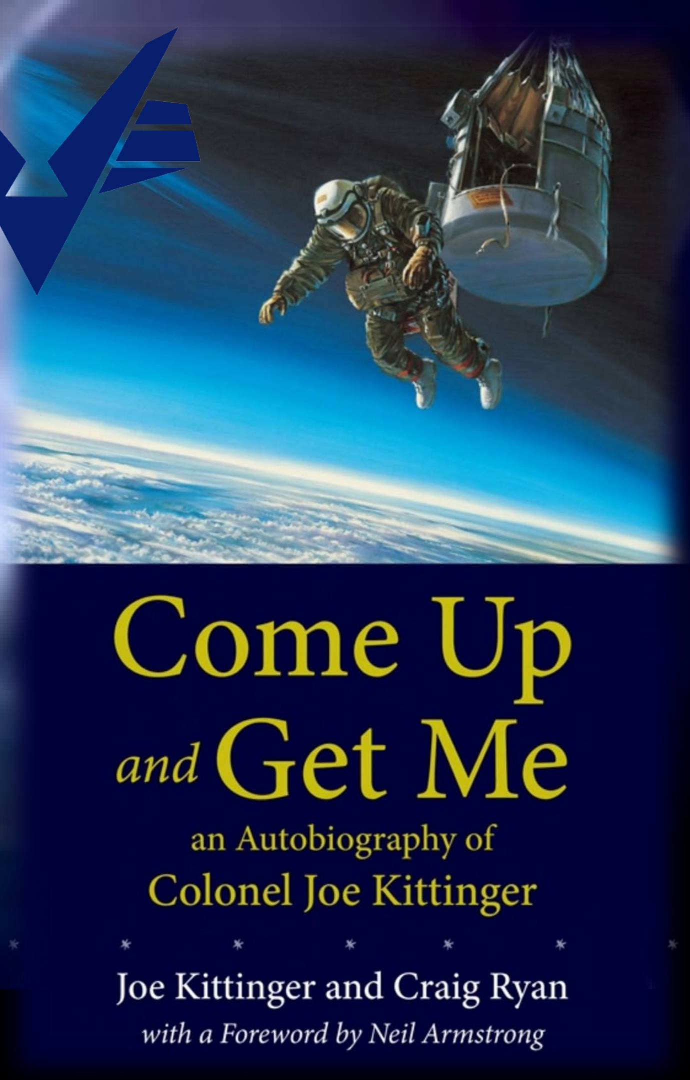
Click HERE to View.

SER-FL-293
Patrick Composite Squadron

Documentary Video Winner: $350 Grant

MAR-VA-007
William P. Knight
Composite Squadron

Click HERE to View.



And, now, for
the finalists for the
2023
Col Joe Kittinger Cup
and
$5,000 cash prize
from the Kittinger Family…

Note: If any
Kittinger Cup
finalist or winner
was also a finalist
in another category,
the finalist or winner
will only receive one grant;
the highest amount prize.

The Kittinger Cup finalists with the highest cumulative scores are….

Kittinger Cup
3rd Place Winner
~$400 Grant

NCR-MO-127
Trail of Tears Composite Squadron

Kittinger Cup
2nd Place Winner
~$500 Grant

MAR-NC-048

Raleigh-Wake Composite Squadron

Kittinger Cup & $5,000 Winner

Much Appreciation to Mrs. Kittinger!

GLR-WI-183
Stevens Point Composite Squadron

CIVIL AIR PATROL
U.S. AIR FORCE AUXILIARY

Cold Welding in Low Earth Orbit

GLR-WI-183 Stevens Point Composite Squadron, Stevens Point, WI

High Altitude Balloon Challenge

Launch Date: August 5, 2023
Maximum Altitude: 100,318 ft

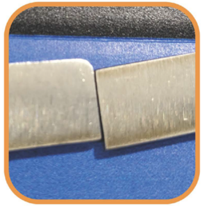
Background

The Galileo spacecraft, launched by NASA in 1989, faced an issue known as cold welding during its mission to explore Jupiter and its moons. The spacecraft's exposure to the harsh conditions of space led to the accumulation of atomic hydrogen on the metal surfaces. When these surfaces came into contact, cold welding occurred, preventing the satellite umbrella from opening.
This story made us ask how cold welding can be useful in space and how it could be made to happen on purpose.

Hypothesis

Cold welding will take place between various metals under the extreme conditions of Low Earth Orbit (LEO) above 90,000 feet.

By pairing compatible, like metals with clean surfaces and sending them into a vacuum (LEO) atomic bonding will occur and two or more pieces or parts will become one single joined part.



Materials

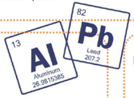
- Two pieces of aluminum polished and secured together with pipe tape
- Tin/Lead welding wire twisted around copper
- Stainless nut and bolt, paired
- Thin aluminum wire bundle, twisted
- 2 plastic test tube capsules: flight and control

Our materials post launch are shown to the right. An image of the oxidation is shown to the left.

Testing Method

We performed mig welding to see how welding works on earth and understand bonded metal. We then secured select metal pairs with pressure (either with pipe tape or by twisting or by nut/screw). We sent a 40 gram test tube on the High Altitude Balloon where it reached 100,318 feet or approximately 30K meters above sea level. At this altitude expected temperature could be between -55 and -3 degrees F. We do not know how long the balloon was at this altitude but it can be reasonably assumed it was a short time before burst. When returned to us, we unpacked and checked visually and tactilely by attempting to separate the metals to see if bonding had occurred post launch.

Metallic Bonding



Metallic bonding is a force that holds atoms together in a metallic substance.
Metals in an oxygen rich atmosphere like earth's have an oxide layer at their surface, and this oxide layer gets in the way of bonds forming. In a vacuum, that oxide layer is outgassed, so it's no longer present. With the oxide layer gone, atoms in the two metals can't "tell" that they are at the surface, so they bond to each other as if they are not. In doing so, they are in fact no longer at the surface.

Implications of Results

Although we hoped to utilize a weather balloon launch to study cold welding, we learned instead that atomic bonding would be easier to study in a lab on earth, where a vacuum can be created to mimic a significantly higher altitude. Future research into atomic bonding and cold welding in space should be studied first in a lab and then at a minimum of 62 miles and then, preferably at higher altitudes or in microgravity environments. The results of our failed experiment at 100,000 feet underscore the challenges of conducting complex experiments in extreme conditions. While the balloon launch provided valuable insights into the difficulties of studying cold welding in such an environment, it also highlighted the importance of carefully planning and controlling experimental variables. By conducting initial laboratory experiments, researchers can establish a solid foundation for their investigations before venturing into space or extreme altitudes.

Minimum Test Requirements

In 1969, a 10 -day experiment was run at NASA's JPL Molsink facility, a unique extreme-high-vacuum research lab, to determine the minimum environmental requirements to perform cold-welding tests. It was determined that a TRW ion-pumped vacuum chamber would be enough to sufficiently run the test, allowing for a cheaper and more accessible test. Cold welding should be adequately tested with an ion-pump machine like used in nanotechnology labs.

U.S. Standard Atmosphere vs. Altitude - Imperial Units

Geo-potential Altitude above Sea Level - h - (ft)	Temperature - t - (°F)	Acceleration of Gravity - g - (ft/s^2)	Absolute Pressure - p - (lb/in^2)	Density - ρ - (10^{-4} $slugs/ft^3$) (lbs/ft3)	Dynamic Viscosity - μ - (10^{-7} $lb\ s/ft^2$) (10^{-7} slug /(ft s))
-5000	76.84	32.189	17.554	27.45	3.836
0	59	32.174	14.696	23.77	3.737
5000	41.17	32.159	12.228	20.48	3.637
10000	23.36	32.143	10.108	17.56	3.534
15000	5.55	32.128	8.297	14.96	3.430
20000	-12.26	32.112	6.759	12.67	3.324
25000	-30.05	32.097	5.461	10.66	3.217
30000	-47.83	32.082	4.373	8.91	3.107
35000	-65.61	32.066	3.468	7.38	2.995
40000	-69.70	32.051	2.730	5.87	2.969
45000	-69.70	32.036	2.149	4.62	2.969
50000	-69.70	32.020	1.692	3.64	2.969
60000	-69.70	31.990	1.049	2.26	2.969
70000	-67.42	31.959	0.651	1.39	2.984
80000	-61.98	31.929	0.406	0.86	3.018
90000	-56.54	31.897	0.255	0.56	3.052
100000	-51.10	31.868	0.162	0.33	3.087
150000	19.40	31.717	0.020	0.037	3.511
200000	-19.78	31.566	0.003	0.0053	3.279
250000	-88.77	31.415	0.000	0.00065	2.846

Vacuum Matters & the Kármán Line

Deep space is generally much emptier than any artificial vacuum that can be created in a laboratory, although many laboratories can reach a lower vacuum than that of low earth orbit. The problem is that this true vacuum happens at 62 miles above sea level - this is called the the Kármán line.

Were we high enough? No - our balloon only got 30% of the way there - and for a very short time. Given the difficulty of getting an experiment to or past the Kármán line, it would be recommended instead to replicate this in a laboratory environment where a controlled vacuum situation can be achieved.

Atmosphere vs. Altitude Chart (2)

Asking Questions

So what happened?
Our research suggests that for our test tube, the altitude was too low, the time too short, and the amount of friction or pressure too low for cold-welding to occur. Our post launch hypothesis is as follows:
Studying cold welding in a laboratory setting on Earth is better than conducting experiments in Low Earth Orbit (LEO) due to the ability to create vacuum conditions and precisely control environmental variables, leading to a more detailed understanding of cold welding.
Post-launch questions we asked included:
What caused our experiment to fail to weld?
What would it take for cold welding to occur?
How can we test our theory?

Conclusions & Discussion of Results

No materials showed signs of cold welding adhesion. Some metals showed significant surface oxidation, more in the launch capsule than in the control capsule. While it is possible that oxidation rates were increased in LEO, we cannot absolutely determine the equal cleanliness of each surface area.
We concluded that in order to prove our initial hypothesis, we would need more time at a higher altitude with fully controlled conditions, like found in a laboratory environment.
While it was disappointing not to see cold welding occur, we are not discouraged as we do know it can be done! We hope to see cold welding studied on the International Space Station someday soon.

Friction Makes it Faster

In the 10-day 1969 Molsink experiment, it was determined that "friction appears to be independent of passive vacuum exposure time"(1) with regards to atomic bonding. As a result, a cold welding simulation can be sped up by using mechanical friction.
When friction at an atomic level is deliberately used to facilitate bonding, this would no longer be considered cold welding but instead friction welding or friction stir welding.
While different, it may make welding possible where high heat cannot be used.
Since our initial motivation was to weld in space, this may be a good option to explore.

References

1) Wang, J. T. (1972). Cold-Welding Test Environment. JPL Technical Report National Aeronautics and Space Administration. Retrieved from https://ntrs.nasa.gov/api/citations/19720016873/downloads/19720016873.pdf

2) The Engineering ToolBox. (2003). U.S. Standard Atmosphere vs. Altitude. https://www.engineeringtoolbox.com/standard-atmosphere-d_604.html

3) Merstallinger, A., Sales, M., Semerad, E., & Dunn, B. D. (2009). Assessment of Cold Welding between Separable Contact Surfaces due to Impact and Fretting under Vacuum. European Space Agency STM-279. Retrieved from http://esmat.esa.int/Publications/Published_papers/STM-279.pdf

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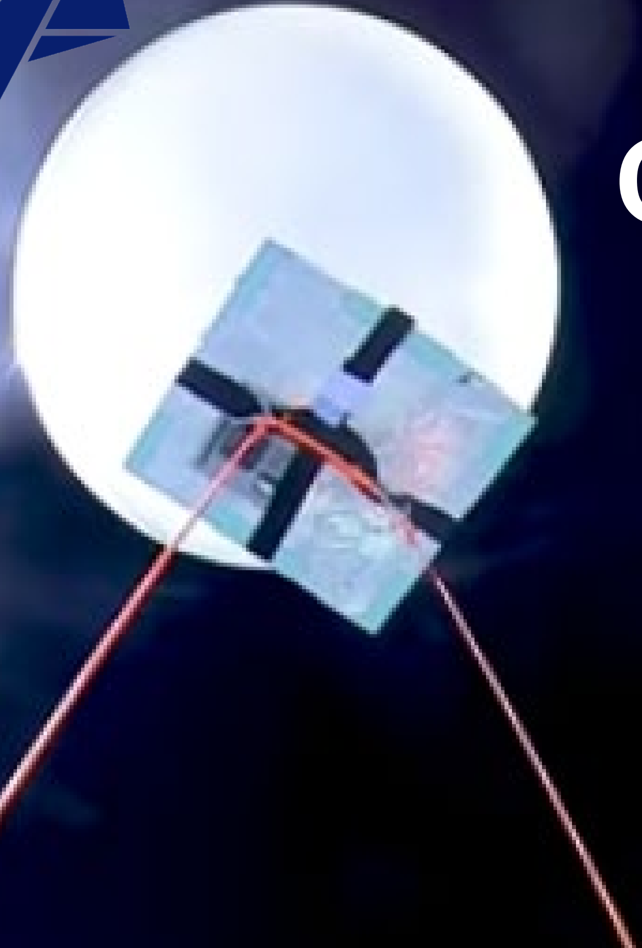
30 Sept 2023 Compiled by C/CMSgt Lily Schaefer for GLR-WI-183 High Altitude Balloon Challenge Team

Kittinger Cup Winner's Science Slide



Congratulations, GLR-WI-183!

See their winning documentary video HERE.

**With gratitude to the
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Tribute to
Col Joe Kittinger for his inspiration and challenge to CAP's cadets to learn more about space science. CAP will be forever appreciative to him, and, to Mrs. Joe Kittinger for keeping Col Joe's dream alive.

In Memoriam:
July 27, 1928- December 9, 2022

"We're at 103,000 feet…
As you look up, the sky looks beautiful, but hostile.
As you sit here, you realize that Man will never conquer space.
He will learn to live with it, but he will never conquer it."

~Joseph Kittinger

Thanks to all cadet teams for participating in the 2023 HAB Challenge. Please join the program again in the future!

See the entire 30-minute awards show video HERE.

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