Make Learning Real

WEATHER BALLOON PROGRAM GUIDE

ALL THE STEPS AND ADVICE YOU NEED TO START A PROGRAM FOR YOUR STUDENTS.

BY JASON KRUEGER

Thank you for your interest in looking at ways to improve student engagement! As a student, I personally struggled with engagement in learning at school and have made it my life's mission to encourage, empower and equip educators to make learning real for students! I hope this information can take you one step closer to your vision!

- Jason Krueger - President/Founder - @stratostar4u

How to Start a Weather Balloon Program

Conducting missions to the edge of space with weather balloons is truly life-changing for everyone involved, but starting and running a program is not for everyone. Educators who enjoy adventure, overcoming challenges, and engaging their students in real-world learning (even if it is messy) tend to thrive with the StratoStar Program. We know educators have a lot on their plates, so we developed this guide to help you develop and plan a weather balloon program. We know you have options in starting your program and we hope this guide will show you how we can support your team, if you choose to work with StratoStar.

Our solutions provide you with all the training (including working with FAA), equipment, supplies, and software to start implementing weather balloon missions within your curriculum for years to come!

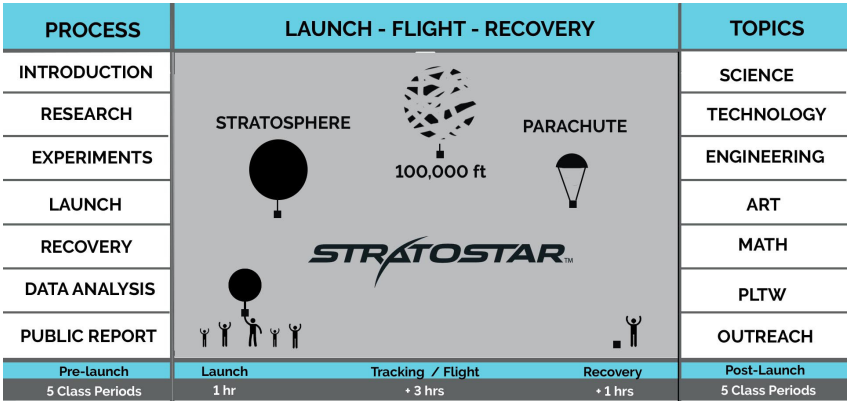
HOW HIGH DO STUDENT PROJECTS ON WEATHER BALLOONS GO?

All the Steps and Advice You Need to Get a Program Started for Your Students
The student projects will travel above 99.9% of our atmosphere as measured by air pressure! The weather balloons will typically reach altitudes of 80,000 to 120,000 ft (24km - 36km) above the Earth before the balloon bursts and the payloads (student projects) fall back to Earth on a parachute. The student projects will be bombarded by radiation inflight, which is very similar to what is detected on the space station, and experience temperatures in the tropopause below -50F (-45C). The picture below was taken with a GoPro from a student project 70,000 ft above Earth!

THINK BIGGER THAN A COOL SPACE VIDEO

You have probably seen a video of the "edge of space" shot from a GoPro online and you want to allow your students to capture footage like this. These videos are some of the most stunning captured on action cameras, but the footage is just the icing on the cake. Each mission has the potential to create learning and an impact that will last a lifetime for your students and community, while at the same time can incorporate lessons from most topics taught in schools.

Here is a diagram of what implementation of a StratoStar program looks like for 10 class sessions and a mission to the edge of space!



RESEARCH-BASED APPROACH

We have helped hundreds of educators start weather balloon programs and even conducted a research study with the National Science Foundation (NSF) to determine best practices for using these missions with students. The #1 issue encountered with using a weather balloon mission within the curriculum was: treating a mission as a short one-time event with limited science and math covered. However, StratoStar has solved this issue and has seen thousands of students and educators inspired and engaged by designing and launching their own experiments to the edge of space and allowing the educators to repeat this year after year!

One of the aspects we looked at within our NSF research was the impact on student learning with a pre/post-test. What we found was that the educators who took time within their classes to teach some of the background knowledge (science and math) and allow for ownership of the project from the students, had much more impact on the students compared to the "one-time" event group.

The other advantage of thinking bigger and covering more subjects/topics or collaborating with more teachers and students is: **funding comes easier. Administrators and donors look at the dollars spent vs the learning impact it can have on students**. So the more time/topics you incorporate for the weather balloon project or the more students involved, the easier it will be to secure funding to start launching balloons!

I have not done a program in 16 years of teaching which has engaged as many students as the StratoStar Program…. we try to reach 100% of our students and this is the closest I have ever been.

Buffy Sexton - STEM Teacher - Jefferson County Public Schools @DuBois_STEM

What Topics Can I Cover in My Courses?

ALL AREAS OF SCIENCE

The StratoStar program is designed to give students an opportunity to apply their classroom and book knowledge while letting them explore concepts further by using science and engineering practices. The StratoStar program has been used in helping students study Weather and Climate, but we have taken a unique approach and allowed students to design experiments which are flown on-board the weather balloon to **study all areas of the Sciences**. We have seen projects from all areas of sciences: **Life Science, Earth & Space Science, Physical Science,** and Engineering. Here is a table with a few of the topics which can be covered with a StratoStar Mission. (See our appendix for more details on topics by grade level.)

Subjects/Topics Which Can Be Covered with StratoStar Missions

Earth & Space Science	• Space Systems • Earth Systems • Weather and Climate • Human Impact
Physical Science	• Structures and Properties of Matter • Chemicals/Elements • Forces and Interactions of Energy • Wav es and Electromagnetic Radiation
Life Science	• Molecules to Organisms: Structure and Process • Ecosystems: Interactions and Energy Dynamics
Engineering/ STEM	• Engineering Design Process • Design Thinking • Problem Solving • Developing Prototypes • Working in Teams
Cross Curricular	• Applying Math Concepts • Writing Technical Papers • Creating Media Explaining Science • Human History of Science and Flight • Literature Research/Evaluation

STUDENTS USE SCIENTIFIC AND ENGINEERING DISCIPLINES

The StratoStar program allows students to conduct experimental research projects onboard a StratoStar High-Altitude Scientific Balloon. During this one-of-a-kind learning experience, the students will solve meaningful problems and investigate the natural world through the lens of scientific inquiry. These are the scientific and engineering disciplines we help your educators and students cover (as defined by Next Generation Science Standards)

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

We have had students go into STEM fields because of the StratoStar Missions. That is pretty freaking cool!

Jon Peirce - STEM & Innovation Coordinator - Cherry Creek School District @jpierce924

HOW DO STUDENTS FLY THEIR EXPERIMENTS?

Students typically work in teams of four to develop an experiment which can be completely student-led or could be guided by the educator with a set of procedures. These experiments can involve physical objects which fly or be completely based on the data which is sent back (i.e. performance of a parachute or altitude of jet stream.) There are two experimental enclosures which students can utilize with StratoStar:

SHARE Capsule		StratoStar Payload Box	
			
Dimensions:	12 cm x 3 cm	Dimensions:	20 cm x 15.5 cm x 10 cm
Volume:	50 mL	Volume:	3.1 L
Weight Limit:	40g	Weight Limit:	1 kg
SHARE Units:	1	SHARE Units:	20

When students design their experiments, they typically use items which can be purchased at local stores or online and can utilize the existing tools on campus (3D printers, hand tools, electronics, camera, etc.). Most experiments will have a control sample on the ground or at least a dataset which is collected before flight to compare the results.

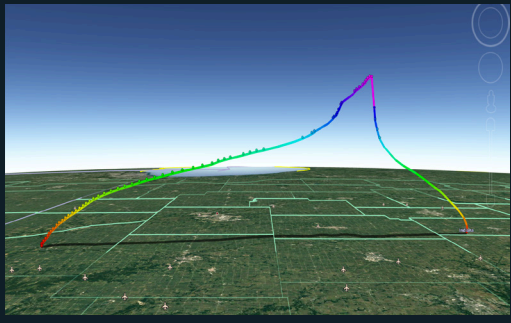
WHAT KIND OF DATA IS COLLECTED DURING A STRATOSTAR MISSION?

All the sensor and location data is collected in real-time and transmitted to the internet to be displayed on your mission page for the students, educators, and community to participate in your mission in real time.

Check out one of our mission pages and be sure to look at all the tabs: Maps, Graphs, Data, and Social. https://tracking.stratostar.net/mission/0106

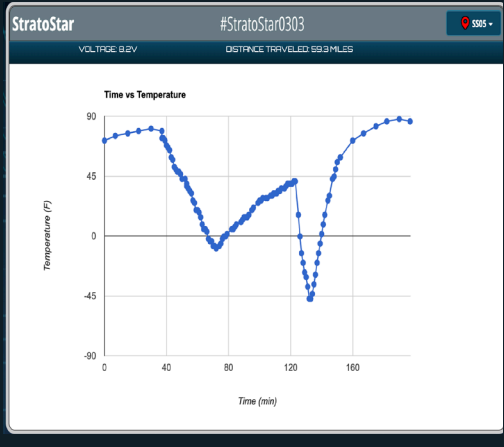
STRATOSTAR MISSION PAGE

GPS / LOCATION DATA



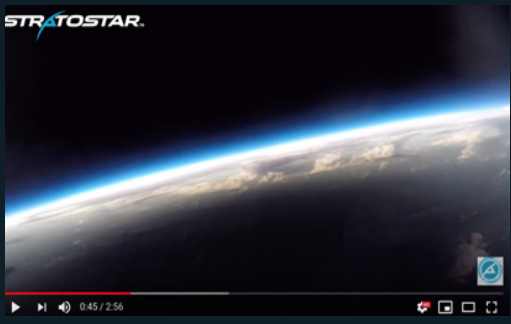
- Altitude
- Ground Speed
- Vertical Rate
- Latitude
- Longitude
- Heading
- Signal Strength

SENSOR DATA



- Atmospheric Temperature
- Atmospheric Pressure
- Atmospheric Humidity
- Internal Temperature
- Pressure Altitude
- 3 Axis - Acceleration
- 3 Axis - Gyroscope (spin)
- 3 Axis - Magnetometer
- 21 Channel GPS

VIDEO / IMAGES



- Horizon Footage (Side)
- Balloon/Sky Footage (Up)
- Ground/Earth Footage (Down)
- Student Projects
- Still Images
- HD Video
- 360 VR Video

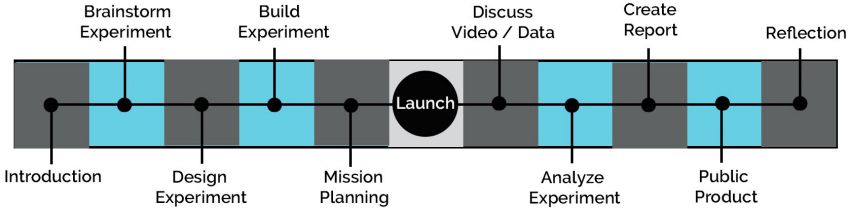
SOCIAL MEDIA

- StratoStar Missions have dedicated a Twitter hashtag for each mission.
- Launch and Recovery teams post to the mission hashtag to provide everyone with real-time updates of the mission status.
- Engage the school community and parents with social media.

HOW MUCH CLASS TIME IS REQUIRED FOR A STRATOSTAR MISSION?

On average, educators use about 10 class periods, but some of our educators have created semester-long courses. Conducting a weather balloon mission is very similar to a NASA mission to space. With a weather balloon mission, there is quite a bit of planning, problem-solving, and assembly before the launch. The launch and mission itself is relatively short (4 hours), which generates data which the scientist and engineers analyze and write papers on for much longer than the mission took to plan and launch.

From a classroom perspective, the launch/mission is the middle of your unit as there is planning and building before, and data, analysis, reports, and reflection on the mission after it has been launched and recovered (this is where the most learning happens).



We have added a list of academic topics and subject areas that can be covered in the appendix of this ebook for your review for the following topics: Science, Math, Writing, Engineering, History / Geography, 21st Century Skills and more.

There is nothing that can fit hands-on STEM like StratoStar. The program has given us access to the whole atmosphere! Andy Wilkins - PLTW Coordinator - Noblesville Public Schools - @MrWilkinsNHS

What Do I Need to Start a Weather Balloon Program?

Weather Balloon - Equipment/Supplies/Support

We understand that there are other options out there for weather balloons including DIY, but **StratoStar has designed all our programs to include everything you need and support you to increase engagement with your students** in the classroom to make learning real. We will provide training to you and your team on all technical aspects of conducting weather balloon missions as well as support in customizing the curriculum for your specific classes. We have designed every aspect of the program to be reliable and sustainable to give you the opportunity to continue conducting weather balloon launches for years to come.

What you are going to need: (StratoStar programs include everything you need!)

- GPS Tracking (unlocked for altitude)
  - Most GPS units don't work over 60,000 ft
- Sensors to measure the atmospheric conditions
- Classroom labs and lessons for student projects
- Long-range radio system to send and receive GPS tracking and sensor data
- Back-up GPS tracking system
- Helium regulator and accessories
- High-altitude balloon and attachment accessories
- Student experiment enclosures
- Flight hardware to connect your experiments, balloon, and tracking devices
- High-altitude parachute
- HD action camera and large SD card
- Hiking GPS for recovery (phones don't work in remote landing zones)
- Training/support to assemble, launch, and recover projects

StratoStar would love to be a part of your journey to inspire your students with a mission to the edge of space!

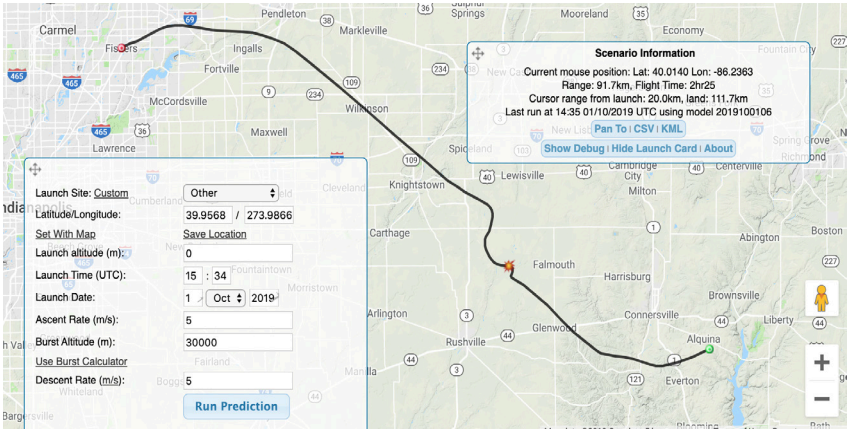
Request Proposal/ Consultation

Do You Know Where the Weather Balloon Will Land?

YES, within an accuracy of about 10 mile radius, using a website which factors in weather forecasts and launch site for weather balloon launch. This is an extremely helpful tool to understand where your chase/recovery teams will be headed for the day.

You can try this tool to simulate a weather balloon launch from your location right now! Use this link and enter the Latitude/Longitude of your location. (You can use Latlon.net to find GPS coordinates by city.)

Weather Balloon Flight Prediction: http://predict.habhub.org/



HOW FAR DO THE WEATHER BALLOONS TRAVEL ON A MISSION?

WARMER MONTHS

Typically in the United States, the distance weather balloons travel is less, as the jet stream is much weaker as compared to the winter months. Typical flight distances for the warmer months will be from 2 to 35 miles (3 to 56 km).

COLDER MONTHS

During the colder months of the year, the jet stream is at its strongest in the United States and weather balloons will have a west-to-east trajectory. We have measured wind speeds of over 200 mph in the jet stream in January over the Midwest! Typical flight distances are from 35 to 90+ miles (65 to 144km).

HOW ACCURATE ARE THE FLIGHT PREDICTIONS?

We typically advise an accuracy of about 10 mile radius around where the flight prediction says it will land (prediction provides one point). The flight predictions are available 5 days before the scheduled launch date, and the most accurate prediction is within 12 hours of the launch, which gives you the most recent forecast which uses government weather balloon data.

What Kind of team Do I Need to Conduct a Mission?

BUILD A TEAM (OTHER TEACHERS/PARENTS/STUDENTS)

Just like NASA, a team is needed to plan and execute weather balloon missions! Our most successful educational programs (made the most impact on students) have more than one educator involved in developing, planning, and running the weather balloon program. There are many different aspects of the program which can be shared and each person can specialize in the lessons/units in the classroom, handling the planning and logistics of the mission to managing parent volunteers for the launch date.

To give you an idea of the help from adults on the launch day, here are some of the roles (could be students as well if they are older):

OVERALL LAUNCH/MISSION DIRECTOR:

This person oversees all of the different teams and logistics of the weather balloon mission from planning, coordinating the mission day, and collecting final student reports. This includes coordination with FAA (or aviation authorities), the launch team, recovery team, helium supply vendor, and coordination with the school or district for launch time/date/location. They also help problem-solve an issue with the other teams.

LAUNCH SITE DIRECTOR:

This person manages the logistics related to setting up the balloon, flight system, student projects, and keeping the timeline to launch. They will monitor the filling of the balloon. Sometimes the launch site is remote and the launch site director will make the plan on where and how the balloon is filled to meet the overall mission timeline.

RECOVERY DIRECTOR

This person is responsible for planning and executing the recovery of the balloon and student projects after it lands back on Earth. We recommend this person is experienced in outdoor activities and knows how to navigate to a GPS coordinate using a hiking GPS (like geo-caching). Most of the time, where the balloons and student projects land, there is little to no cell phone service and the maps/GPS apps don't work. This person, and at least one other person, will secure permission (if needed) to access the land/location to make recovery. In some parts of the world, this may involve significant hikes through tough terrain or even securing a boat for water recovery.

SOCIAL MEDIA DIRECTOR

The social media director will be taking some pictures and video themselves, but more importantly is collecting pictures, videos, and updates from all the teams and posting them to the mission #hashtag on twitter and other social platforms. This allows for the students, teachers, and community to stay up to speed on the progress of the mission.

How Do I Fund
My Weather Balloon

REQUEST A PROPOSAL/CONSULTATION FROM STRATOSTAR:

If your educational organization is located within the United States and you are looking to develop a long-term educational program to engage students in Science or STEM, please use the link below to share some information about your educational organization so we can help develop a plan to share during a consultation leading to a proposal.

Request Proposal/ Consultation

SET IMPLEMENTATION DATE AND SECURE FUNDING

Just like anything in life, setting goals is one of the most important aspects of any project. So selecting a date you would like to implement this will help you narrow your focus on funding sources and resources. We have found that starting local (department, school, district, community) is the easiest source of funding, as it is personal to the people giving the money and they know your students (who they hope will stay and work in the community).

WHAT "THEY" ARE LOOKING FOR WHEN FUNDING PROJECTS IN EDUCATION

The number one thing to increase your chances of securing funding internally at your organization, doing a donors choose, or applying for a national grant is **having a plan and purpose.** When the purpose aligns with current initiatives or areas of the curriculum which need to be boosted, it will make your request rise above the rest. When the purpose is clear and the plan is detailed in how to execute and impact the students, you will be unstoppable!

All of the above steps and information can be placed on the template below to help document this project for yourself and allow you to present it to others who are interested in joining you on this journey. We have found that if you have a "shovel" ready project, it is much easier to get funding and have people get onboard :)

Conducting these missions and maintaining your program relatively requires low capital, but the startup cost can be considerable.

Template for a Weather Balloon Program

Use the following headlines to create a one-page document which can be used within your institution to help get people on board with the idea and give an outline to the people who might fund the program.

Purpose of Program:

- ***Are there any educational initiatives that your organization has discussed?***
- ***What "issue" are you trying to solve or overcome with this program (low engagement, more cross-curricular work, low test scores, etc.)?***

Topics/Standards to Be Covered

- ***Even if this is just a list, it shows that at a basic level the "work" aligns with what the students need to learn (not a distraction from existing education purpose).***
- ***Outcomes for students.***

How Does the StratoStar Program Work?

- **Put into your own words for your application/organization**
  - ***Educators teach core content from existing materials in subject areas of focus (science, math, engineering, 21st-century skills, etc.).***
  - ***Students work in teams to develop experiments using the scientific method and engineering design process.***

- *The student projects are launched to the edge of space on weather balloon 100,000 ft above the earth.*
- *Students, staff, parents, and the community track the mission live online.*
- *Educators and parents assist students in the recovery process of projects.*
- *Students analyze the data and create video from flight footage.*
- *Students present their results in a public forum to the parents and community.*
- *Educators use a rubric to provide a score/grade.*
  Repeat :)

Plan to Implementation:

- *Anticipated start date*
- *Other educators/staff involved - their roles*
- *Number of missions a year (recommend at least 2-3, as it spreads the cost out).*
- *How will you gather materials and information to get the program started? Ideas for funding (suggest internal funding first).*

PR/Marketing Benefits

- *Each mission has the potential for media coverage as well as social media content for the organization showing students "doing" science and engineering!*

Budget:

- *Startup cost*
  - *How long do you anticipate the program running (5 years is typically selected)?*
- Operating cost *(approximately $400 in consumables per launch @ 2-3 per year)*

I would love to connect with you to learn more about your vision for a new learning experience for your students and community. Please fill out the form on the link below and we can start outlining a process of how StratoStar can help get you and your students flying!!!

Keep up the good work! - Jason.

Request Proposal/ Consultation

Middle School Topics & Lesson Table

Using StratoStar's products allows educators to cover a broad range of subjects and topics. Students engage in learning as they working in teams to complete a successful mission to the edge of space just like real Scientist & Engineers. Below you will find a table indicating an example of the subjects, topics and suggested lessons for educators to cover with students throughout a StratoStar Mission. StratoStar will assist educators with implementation of activities into their grade level, curriculum and standards.

	Topics Covered	**Suggested Lesson Ideas**
Math 5th – 8th	Process Standards for Math Number Sense Computation Algebra and Functions Geometry and Measurement Data Analysis and Statistics	Unit Conversion (English / Metric) Interpreting graphs from flight data Identifying Rate and Slope Scale Drawing and 3D Shapes Using Statistics to summarize data Variables in real-world problems Using appropriate tools and technology
Physical Science	Structures and Properties of Matter Chemicals / Elements Forces and Interactions Energy Waves and Electromagnetic Radiation	Properties of Water in atmosphere Helium as lighter-than-air gas Gravity and falling from edge of space Light, Sound and Radio Waves Energy in Earth / Sun relationship Temperature and Heat transfer Chemical Reactions and Air Pollution
Space & Earth	Space Systems Earth Systems Weather & Climate Human Impacts	Earth vs other planets in solar system Water Cycle investigation Human dependence on Atmosphere Jet Stream and Atmospheric energy
Writing / English	Technical Writing Scientific Literacy Public Speaking	Scientific Research Technical Papers Scientific Presentation
Scientific Method	Used in all Experiments	Formation of Question Hypothesis Prediction Testing Analysis
Engineering	Engineering Design Process Used in all Experiments	Ask questions Imagine solutions Make a plan Crate Prototype Evaluate / Improve Repeat Publish / Present
History	Geography Ancient Civilizations (Flight) Civics and Government Industrialization	Identifying Geographical information Research idea of flight through the ages Creation / Funding for FAA, NASA & DoD History of Human Flight Aerospace used in War
21st Century Skills	Communication Creativity Collaboration Critical Thinking	Team work Drawing Conclusions Learning from Failure Flexibility / Compromises

High School / College Topics & Lesson Table

Using StratoStar's products allows educators to cover a broad range of subjects and topics to meet state standards. Students engage in learning as they working in teams to complete a successful mission to the edge of space just like real Scientist & Engineers. Below you will find a table indicating an example of the subjects, topics and suggested lessons for educators to cover with students throughout a StratoStar Mission. StratoStar will assist educators with implementation of activities into their grade level, curriculum and standards.

	Topics Covered	**Suggested Lesson Ideas**
Algebra	Solving Equations Proportions Graphs & Functions Linear Equations Exponential Functions Quadratic Formula Radical Expressions	Unit Conversion Dimensional Analysis Algebraic Proportions Find best fit to Data Graph Exponential Function Rate of Change Scaling
Physics	Motion & Forces Temp & Thermal Transfer Electricity & Magnetism Vibration & Waves Light & Optics Modern Physics Nuclear	Velocities of payloads Parachute Physics Radio Waves Cosmic Radiation Video Cameras Speed of Sound Ideal Gas Law
Chemistry	Properties of Matter Atomic Structure Behavior of Gasses Thermochemistry Solutions Organic Chemistry	Extreme Temperature Changes Extreme Pressure Change Buoyancy Forces Ideal Gas Law Reactions in Atmosphere Freezing Point Depression
Writing / English	Technical Writing Scientific Literacy Public Speaking	Scientific Research Technical Papers Scientific Presentation
Scientific Method	Used in all Experiments	Formation of Question Hypothesis Prediction Testing Analysis
Engineering	Engineering Design Process Used in all Experiments	Ask questions Imagine solutions Make a plan Crate Prototype Evaluate / Improve Repeat
Space & Earth	The Universe Solar System Earth Science Atmosphere Weather Pollution	Cosmic Radiation Layers of Atmosphere Sun as a Star Earth from Above Pollution in Atmosphere Cloud Identification
21st Century Skills	Communication Creativity Collaboration Critical Thinking	Team work Drawing Conclusions Learning from Failure Flexibility / Compromises