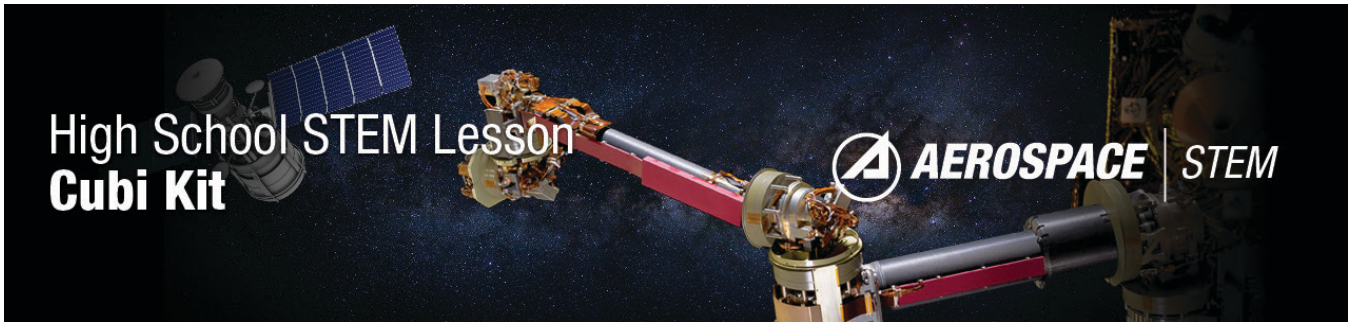

Team Name:		Date:	

CUBESAT MISSION

You are part of the ground control team for a small spacecraft. Your spacecraft has just been delivered to its orbit around the Earth by a rocket. Determine who on your team will act as commander.

The commander for my team is _____.

Part 1:
Establish Communication

You must establish communication with your spacecraft to determine if it's operational.

Communications Procedure:

1. Using your commander's laptop or other device, scan for the Wi-Fi of your Cubi Kit. Connect.
2. Open a browser window (Chrome, Safari, etc.).
3. Enter the following URL in the address bar: http://192.168.4.1/
4. You should now see "STEMkit Mission Data Downlink."

If your commander **cannot** establish communications, do not go further. See the flight director for assistance.

Part 2:
Systems Check

What are the capabilities of your spacecraft and its sensors?

Component	Purpose	Units
Solar Array	*Collection of solar cells* Solar cells, or photovoltaic cells, are electronic devices that convert the energy of light into electricity using the photovoltaic effect.	Power in Watts *(W)*

Make sure the SOLAR ARRAY **is functioning properly. Most satellites use solar array to generate power using energy from the sun. As our satellite orbits the Earth, it will charge its batteries whenever it's in view of the sun. Today we will simulate the sun with a flashlight.**

Look at the data for the SOLAR ARRAY **for the following questions:**

1. What is the horizontal-axis measuring? _____
2. What is the vertical-axis measuring? _____

Component	Purpose	Units
Photocell	*Resistor that changes its resistance depending on the amount of incident light*	Light Intensity (lumens/m^2)

We know our solar array is working, but we need to orient our spacecraft to face the sun. The PHOTOCELL **can be used to locate the sun and measure the intensity of light. The** PHOTOCELL **is commonly referred to as a "sun sensor."**

Look at the data for the PHOTOCELL **and use the flashlight to simulate the sun for the following questions:**

1. What is the horizontal-axis measuring? _____
2. What is the vertical-axis measuring? _____
3. What is the HIGHEST value you can achieve on the vertical-axis? _____
4. What action did you take to achieve this value? _____
5. What is the LOWEST value you can achieve on the vertical-axis? _____
6. What action did you take to achieve this value? _____

Acceleration, rotation and magnetic fields **are all measured by ONE component on our spacecraft: the** Inertial Measurement Unit (IMU)**. All of this information can be used to help our spacecraft understand its position and how it's moving.**

Accelerometer:

Component	Purpose	Units
IMU Accelerometer	*Inertial Measurement Unit* Accelerometer measures acceleration of body in its own frame	Acceleration in milli-gravity (milli-G)

Our spacecraft can measure ACCELERATION **in three directions: x, y, and z.**

Look at the data for the IMU ACCELEROMETER **and move the spacecraft up, down, and side to side for the following questions:**

- The **horizontal-axis** is measuring **time.**
- The **vertical-axis** is measuring **acceleration in milligravities.**

Move the spacecraft up and down. Notice the data.

1. Is the movement affecting the x, y, or z acceleration? _____
2. What is the HIGHEST value you can achieve? _____
3. What is the LOWEST value you can achieve? _____

Move the spacecraft side-to-side. Notice the data.

1. Is the movement affecting the x, y, or z acceleration? _____
2. What is the HIGHEST value you can achieve? _____
3. What is the LOWEST value you can achieve? _____

Gyroscope/Rotation:

Component	Purpose	Units
IMU Gyroscope	*Inertial Measurement Unit* Gyroscope measures angular velocity	Degrees/Second (deg/sec)

Turn your spacecraft clockwise. Notice the data.

1. Is the movement affecting the x, y, or z acceleration? _____
2. What is the HIGHEST value you can achieve? _____
3. What is the LOWEST value you can achieve? _____
4. What actions did you take to achieve these values? _____

Magnetometer/Magnetic Fields:

Component	Purpose	Units
IMU Magnetometer	*Inertial Measurement Unit* Magnetometer measures the magnetic field around the Cubikit	Microteslas (μT)

This data shows the strength of the magnetic fields your spacecraft is measuring. The sensor can be used to measure the Earth's magnetic field, but it can also pick up the magnetic fields of nearby objects.

Move your flashlight near the spacecraft. Notice the data. Take turns moving other objects near the spacecraft (cell phone, laptop, pen, watch, battery, etc.). Notice the data.

1. How do the magnetic field measurements change? _____
2. What is the HIGHEST value you can achieve? _____

   What action did you take to achieve this? _____
3. What is the LOWEST value you can achieve? _____

   What action did you take to achieve this? _____

After manipulating the objects and seeing the effects on the magnetometer, how would you design your CubeSat so that nothing interferes with the function of the magnetometer? _____

Approval from your Flight Director is needed to continue with your mission _____

The commander for your team should choose one other student connect to your Cubi Kit and open the data downlink page. This laptop will display data for the mission while the commander inputs differing commands.

Part 3:
Initiate Normal Mode to Achieve Mission Objective

Commander, make sure all hands are away from the Cubi Kit, and that the spacecraft is in the middle of the table. Signal to your spacecraft that it should track the sun:

- Add **set?mode=normal** to the end of the IP address. (http://192.168.4.1/set?mode=normal)
    - Your spacecraft should now be rotating on the table.
    - Use the flashlight to simulate the sun. You may have to place the flashlight closer to the photocell to detect the "sun."

What's the **farthest** distance the "sun" can be from your CubeSat in order to correctly orient to the sun?
_____ cm

Part 4:
Assist Exploration and Robotics Research Orbital Reconnaissance

While your team's CubeSat continues nominal operation, you've been asked to assist the Exploration and Robotics Research Orbital Reconnaissance (ERROR) team on their current satellite mission.

The ERROR team is experiencing a control system failure: The satellite is rotating erratically and not tracking the sun.

One ERROR team member, in a stress-induced bout of creativity, has reportedly pirouetted out of mission control while uttering a techno-jargon rap:

> *We launched the satellite, aimed for the stars, but now it's spinning wild, like it's cruising in bizarre.*
> *Thrusters misbehaving, propulsion in a trance, I'm coding on the fly, doing a control dance.*
> *Satellite spinning, like a record on repeat, my stress levels rising, can't accept defeat.*
> *Satellite spinning, in this cosmic ballet, I'm spitting verses, trying to find my way.*

Experience the Problem:

While the ERROR team helps their teammate can regain self-control, you are about to simulate the ERROR team's control system. Make sure all hands are away from the Cubi Kit and that the base of the Cubi Kit is on the table.

- Be prepared to analyze the data to see what is causing the error.
- After seeing the performance of ERROR team's satellite, you will put it in a safe mode to gain control allow you to diagnose and decide upon a fix for the issue.

1. Commander, input "set?mode=sim_error" to the end of the IP address
   http://192.168.4.1/set?mode=sim_error

2. The ERROR team's satellite is out of control! Now that you've seen how the satellite is performing, have the commander send the signal for it to operate in safe mode and stop spinning:
   Input "set?mode=safe" to the end of the IP address
   http://192.168.4.1/set?mode=safe

Diagnose the Problem and Implement a Solution:

1. Notice the data. Look at each sensors measurements and compare it to the data from your systems check procedure.

2. What sensor appears to be causing the problem? _____

3. How can we correct this? Are there sensors that appear to be working correctly?

Work with your team to **determine another sensor that could be used in place of the sensor that is malfunctioning.** Report your proposed solution to the flight director to receive a new command:
_____http://192.168.4.1/set?mode=_____

Part 5:
Wrap-Up of Cubi Kit Mission

Choose one of the following activities to showcase your learning.
Complete with your team:

❖ Poetry for People Who Can't Rhyme:

Write a haiku about CubeSats and satellite missions. (Remember, a haiku is a short 3-line poem following the 5-7-5 syllable format.)

❖ Force an Analogy:

Explain how CubeSats are like a _____ (see your flight director for the object/action).

❖ Share Your Thoughts:

Revisit the case studies and rank the projects based on their importance.
Justify your most important and least important choices with an explanation.

❖ Techno-Jargon Rap:

Write (and maybe perform) a continuation and happy ending to the ERROR team member's stress-induced rap including your data analysis and solution your team offered.

Team Response: