



STEM SATELLITES

Mission: Stars



Contents

Introduction to STEM Satellites.....	2
Purpose.....	2
Mission: Stars	3
LEGO Mindstorms	3
Get to Know the LEGO® Mindstorms EV3.....	3
Connecting the EV3 to Wi-Fi and the iPad	4
LEGO EV3 Classroom App.....	5
Story of Light.....	6
Part I: Light Waves.....	6
Part II: Investigating Infrared	7
Gathering Light.....	8
Exoplanets	9
Cleaning, Sanitization, and Inventory.....	10



Introduction to STEM Satellites

Purpose

Orlando Science Center, in partnership with the University of Central Florida (UCF), will engage chronically ill children—along with other underrepresented youth ages 9 and up—with unique NASA-themed aeronautics, space exploration, and space science mobile exhibits. The Science Center has partnered with planetary science experts and education researchers from UCF in developing this content.

These mobile STEM (Science, Technology, Engineering, Math) exhibits provide chronically ill children with meaningful science and mathematics resources and activities. This document will be a resource to assist hospital facilitators with use of the mobile exhibits and as a guide for delivering the Mission: Stars content. Project goals align with NASA's education goal of engaging Americans in NASA's mission through strategic partnerships and linkages with STEM education providers in order to promote STEM literacy and awareness of NASA's missions.

STEM Satellites addresses the following goals through these activities:

- Provide experiential authentic STEM opportunities;
- Develop educational strategies to improve STEM instruction to interest youth in STEM professions; and
- Motivate youth to seek STEM careers.



Mission: Stars

Participants will use the Mission: Stars landing page at <https://satellites.osc.org/stars> to navigate all tasks and supplemental resources. They are encouraged to go beyond the activity pages to explore as much as they'd like about the topics presented.

The landing page orients the participant to how the task pages are set up and how to use the information provided.

LEGO Mindstorms

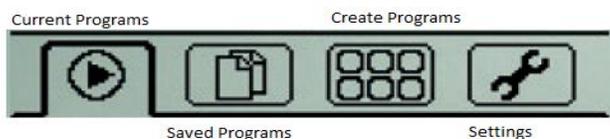
Full User Guide: https://le-www-lives.legocdn.com/ev3/userguide/1.4.0/ev3_userguide_enus.pdf

Get to Know the LEGO® Mindstorms EV3

Display

The display shows the EV3 Brick interface which allows you to maneuver around the software. To navigate around the interface use the Brick Buttons. These buttons may also be used as activators in programming.

There are four main tabs on the interface:



The Brick Status Light indicates the current status of the EV3.

- Red – Start-up, Updating, Shutdown
- Orange – Alert, Ready
- Green – Ready

Ports

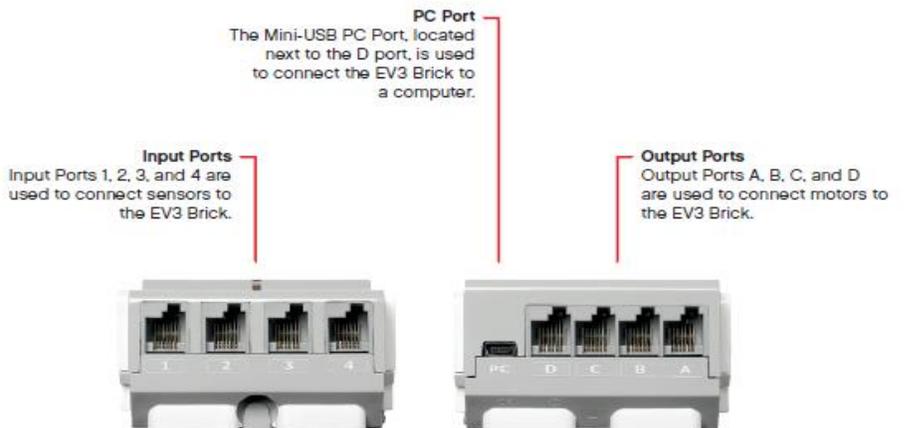
The EV3 uses multiple ports to connect to the various motors and sensors.

It is important to note which ports are used for each external component. The numbered ports (1-4) are input ports that are used to connect sensors. The alphanumeric (A-D) ports are



output ports used to connect motors. There is one micro USB port used to connect the brick to a computer.

The EV3 comes with a rechargeable battery pack. The battery pack is charged via a power adapter cord plugged into the circular charging port on the battery pack.



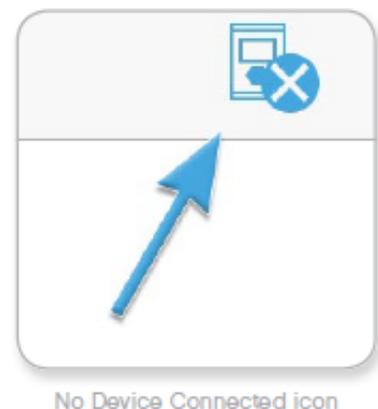
To turn on the brick, press the center dark grey button. The status light will glow green when the brick is ready to use. Turn the brick off by pressing the large gray button under the left side of the display, a shutdown screen will appear. Select the check and press the center button.

Connecting the EV3 to Wi-Fi and the iPad

For the brick to work successfully with a tablet it will need to have Bluetooth and Wi-Fi access.

Making a Bluetooth connection

1. Scroll over to the setting tab (wrench icon) on the brick. Highlight and select the Bluetooth box. If the participant is using an iPad, iPhone, or iPod, they will also need to select the iPad/iPhone/iPod box.
2. Make sure Bluetooth is enabled on the participant's device. Open the LEGO Programming app and open a new program
3. Tap on the top right "No Device Connected" icon.
4. Tap the large blue "Connect" button.
5. A list of nearby EV3 device names will appear.
6. Select the brick you would like to use.
7. Accept the connection on the brick manually.



Making a Wi-Fi connection

1. Select Wi-Fi in the settings tab on the brick.
2. Press the center button for OK.
3. A secondary box will appear; select the check and press the center square button.



File Navigation

There will come a time when each brick will have a number of unnecessary programs stored on it. Follow these steps to delete the files from the bricks:

1. Scroll to the file navigation icon (2 stacked pages).
2. Select the unneeded file and press okay 2 times.
3. A secondary box will appear. Highlight the trashcan and select.

LEGO EV3 Classroom App

The LEGO EV3 Classroom App is where participants will be able to create and upload their own EV3 programs, run through tutorials, and explore all the robot has to offer.

Consult the app's help screen for more complete information on how to use it. In general, it has five main areas:

1. Home
 - a. Access all other areas of app.
2. Start
 - a. Has links to tutorials to get participants started with the robot and the app.
3. Units
 - a. Gives students many jumping-off points and project ideas.
 - b. Many STEM Satellites missions build on the skills gained under the Robot Trainer sub-menu.
4. Build
 - a. Gives building instructions for many types of robots.
 - b. The Driving Base is the recommended starting point for most STEM Satellites projects.
5. My Projects
 - a. Stores projects for participants to come back to later.
 - b. It is a good practice to delete projects between users. Select unwanted projects and press "delete" to remove them from the device's memory.



Story of Light

Part I: Light Waves

Goals

- Program a LEGO robot to draw light waves.
- Investigate light waves in the Wavelength AR app.

Materials

- Samsung tablet with Wavelength AR app installed
 - App may be downloaded from Facilitator Resources webpage
- LEGO EV3 robot, built into a Wave Drawing Machine
- rubber gasket for EV3 robot
- drawing platform
- ruler
- marker pages
- blank paper (optional)
- writing tool (ballpoint pen or marker)

Setting Up

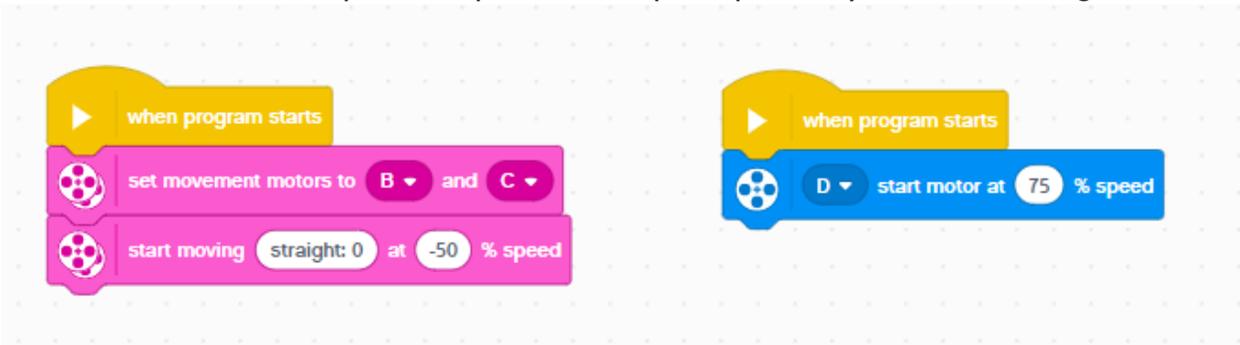
1. Set out the drawing platform with the robot and writing tool.
2. Open the Wavelength AR app on the Samsung tablet and let it run in the background.
3. Open the LEGO Programming app and load the Wave Drawing program. The program is copied below in the event that it gets deleted from the tablet.
4. Connect the EV3 robot to the tablet via Bluetooth following procedures on app.
5. Set out marker pages and (optionally) blank paper near the robot. Make copies of the marker page when necessary. The original file is available on the STEM Satellites Facilitator Resources webpage.

Facilitation Tips & Tricks

- If participants report that the robot is not functioning properly, check the following:
 - Is it still connected to Bluetooth?
 - Are the correct motors plugged into the ports indicated in the program? Change the program or cord arrangement so these match.
- If the robot comes apart, you may attempt to repair it yourself. If you are unable to repair it, replace this activity with a different one and notify the Education Specialist who oversees the STEM Satellites program that the robot has come apart.
- The Wavelength AR app will fill in the circles in the top right corner as different wavelengths are seen. We ask you to restart the app between guests so they can try to complete all 7 colors on their own.
- The Wavelength AR app is controlled by human input. It reads the marker page to know which data set to pull up, but the wave display is manipulated by the user. Therefore, it is possible to see all 7 colors without drawing a single wave!
 - Participants may keep their wave drawings if they wish. Otherwise these papers must be discarded per hospital protocols.



- This is an example of sample code that participants may use in their design:



Here, they have written their code so that when the program starts, the movement motors connected to ports B and C move straight at -50% of their maximum speed. This is because with this particular build, the forward direction on the track is the negative direction with respect to the EV3 brick. At the same time, the drawing arm motor attached to port D moves at 75% of its maximum speed. Changing either or both of these speeds will affect the look of the drawn wave.

Breaking Down

1. Clean and sanitize all materials per hospital procedures.
2. Charge the Samsung tablet via USB-C cord.
3. Charge the LEGO EV3 robot with its charger. The charging port is located under input ports 2 and 3 on the bottom side of the brick (as seen with the screen facing you).
4. Recycle or discard any used marker pages or scrap paper.
5. Make copies of the marker page to replenish. The original file may be found on the STEM Satellites Facilitator Resources webpage.
6. Return materials to the Mission: Stars cart once charged.

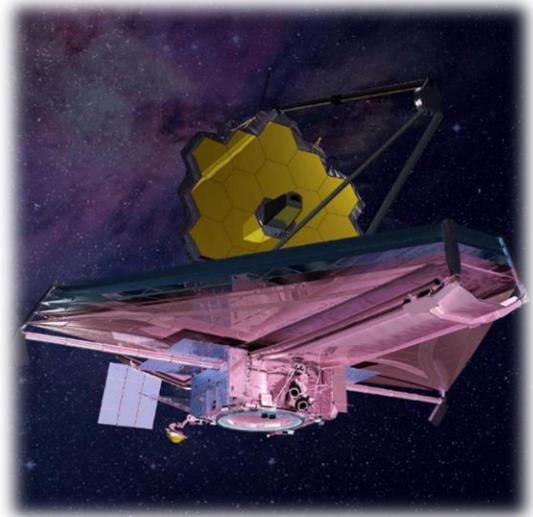
Part II: Investigating Infrared

Goal

- Test a new infrared camera that will detect light that has passed through nebulae and dust clouds. This camera is modeled after the James Webb Space Telescope, which will look at infrared light in space.

Materials

- Samsung tablet
- model James Webb Space Telescope (JWST) camera
- model star field
- 6 sample materials:
 - aluminum, blue gel, felt (one layer), felt (two layers), black cardstock, white cardstock



Setting Up

1. Turn on the JWST camera.
2. Open the tablet's wireless network settings and connect to the Mission: Stars Network. This may be misnamed as Mission: Mars. It may take up to a minute to appear.
3. Open the iPad's web browser and navigate to `192.168.1.1:8081`

Facilitation Tips & Tricks

- Participants will have fun trying the different samples! Allow them to try different materials in their rooms and see if those will block light as well.
- Some smart phone cameras also lack infrared filters! Children may try looking at the star field through their own camera apps.
- The infrared light emitted by the star field is the same as the IR light emitted by remote controls! Try this out with a television remote control if one is available.
- Compare the long-wavelength invisible IR light to other invisible forms of light, such as microwaves, X-rays, and ultraviolet light.

Breaking Down

1. Clean and sanitize all materials per hospital procedures.
2. Reconnect tablet to hospital Wi-Fi network. Charge it if needed.
3. Charge the JWST camera and star field on wireless induction chargers. A light will come on the back of the telescope to indicate it is charging.
4. Return materials to the Mission: Stars cart once charged.

Gathering Light

Goals

- Model various light paths on the model Near-Infrared Spectrometer (NIRSpec) on the James Webb Space Telescope.
- Direct the laser beam from the coupling optics to the detector.

Materials

- Samsung tablet
- model NIRSpec game board
- 1 of each: detector, calibration assembly, filter wheel, coupling optics
- 6 mirrors



Setting Up

1. Arrange telescope part pieces next to game board.
2. Open the Challenge Card web page from <https://satellites.osc.org/stars/challenge-cards/> on tablet web browser. There should be a shortcut link on the iPad home screen.



Facilitation Tips & Tricks

- About the Pieces
 - Coupling Optics: This is a laser beam that models starlight that has come into the JWST. There is a switch on top that turns the laser on and off. Leave it turned off until ready to test.
 - Mirrors: These are standard mirrors set at a 45° angle. Light bounces off the reflective surface at a 90° angle. Light that hits the back or side is lost.
 - Filter Wheel: This component filters light on the real JWST. Here, it forces participants to direct their light through it from front to back. Light that hits the side is lost.
 - Calibration Assembly: This piece is a blocker that prevents certain squares from being used. Light may travel over the top but pieces may not be placed there.
 - Detector: Lights up & makes a sound when it is hit with the laser beam. Sometimes ambient light sets it off. If this happens, move the entire station to a different area in the Hive.
- We recommend that participants begin with Challenge #1 and work through them from there. However, they may complete the challenges in any order they wish.
- If participants get stuck, ask them to trace the path of the laser light with their fingers. What happens when the light interacts with this object?
- There is a slider on the bottom of each challenge card that will gradually reveal hints until providing one of possibly several solutions.

Breaking Down

1. Clean and sanitize all materials per hospital procedures.
2. Charge tablet if needed.
3. Charge detector and coupling optics on wireless induction chargers.
 - a. The detector lies flat on its back.
 - b. The coupling optics un-couples from its base and lies on its back.
4. Return materials to the Mission: Stars cart once charged.

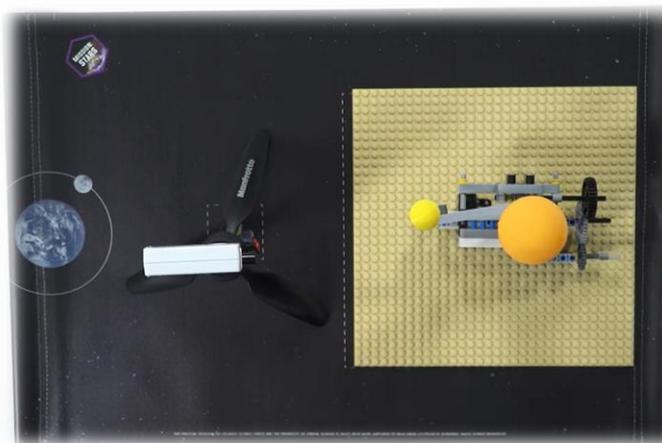
Exoplanets

Goals

- Construct a model solar system, called an orrery.
- Simulate the transit method of planet detection by collecting light curve data.

Materials

- Samsung tablet with SAM Space and SPARKvue apps installed
- LEGO® Technic set
- SAM Labs circuit pieces



- PASCO light sensor with tripod
- Exoplanets activity mat

Setting Up

1. Lay out materials on the Exoplanets activity mat.
2. Review orrery building instructions.
3. Double-check that SAM Labs circuit pieces are charged.

Facilitation Tips & Tricks

- The orrery building instructions include a few stabilizing structures on the bottom. Participants may feel free to modify these structures as needed; for example, they may need a wider base of support if using a longer planet arm.
- Children may need assistance turning on SAM Labs circuit pieces, especially if they have medical issues making their hands or fingers weak.
- Children may also need assistance attaching the PASCO light sensor to the tripod.
- Both the SAM Space and SPARKvue apps have built-in help and support menus that will help both you and the participants navigate them.

Breaking Down

1. Clean and sanitize all materials per hospital procedures.
2. Charge tablet if needed.
3. Charge SAM Labs circuit pieces with micro-USB chargers.
4. The PASCO light sensor uses a watch battery. It should not need to be replaced often.
5. Return materials to the Mission: Stars cart once charged.

Cleaning, Sanitization, and Inventory

Follow your hospital's sanitation protocols to clean items between participants. The following tips may help but are no replacement for your site's guidelines:

- Larger materials (such as the EV3 IntelliBrick, tablets, and mats) may be wiped down with purple-top Super Sani-Cloth wipes as needed.
- LEGO pieces: Collect into mesh bag and place in a dishwasher. Run on a high temp heavy cycle with a no heat, air dry only setting. Heat dry settings may damage pieces.
 - Alternatively, the mesh bags may be dunked into a dilute bleach solution and allowed to air dry.
- Check with your hospital whether Sani-24 germicidal spray may be used for small parts instead of a dishwasher or bleach dunk. Follow manufacturer instructions.

As you are cleaning, please complete the Mission: Stars sign-out and sign-in sheets and inventory forms linked on the STEM Satellites Facilitator Resources webpage. Please also fill out a technology troubleshooting ticket whenever something does not function as intended.

