FIRST® LEGO® LEAGUE JR.

ENGINEERING NOTEBOOK

FIRST®

LEGO education

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The mission of *FIRST* is to inspire young people to be science and technology leaders by engaging them in exciting mentor-based robotics programs that build STEM skills, inspire innovation, and foster well-rounded life capabilities including self-confidence, communication, and leadership. Learn more about *FIRST* Programs: firstinspires.org.

LEGO Education offers playful learning experiences and teaching solutions based on the LEGO system of bricks, curriculum-relevant material, and physical and digital resources to preschool, elementary, middle school and after school. In partnership with educators for more than 35 years, we support teaching in an inspiring, engaging and effective way. Our educational solutions enable every student to succeed by encouraging them to become active, collaborative learners, build skills for future challenges, and establish a positive mindset toward learning. Learn more at LEGOeducation.com. Follow us on Twitter @LEGO_Education.

FIRST LEGO League Jr. gratefully acknowledges its collaboration with Sea Research Foundation, Inc., a 501(c)(3) nonprofit organization. The mission of Sea Research Foundation is to inspire people to care for and protect our ocean planet through conservation, education, and research. Sea Research Foundation operates Mystic Aquarium — one of America's premier nonprofit marine science research and education institutions, and an accredited member of the Association of Zoos & Aquariums and the Alliance of Marine Mammal Parks and Aquariums.

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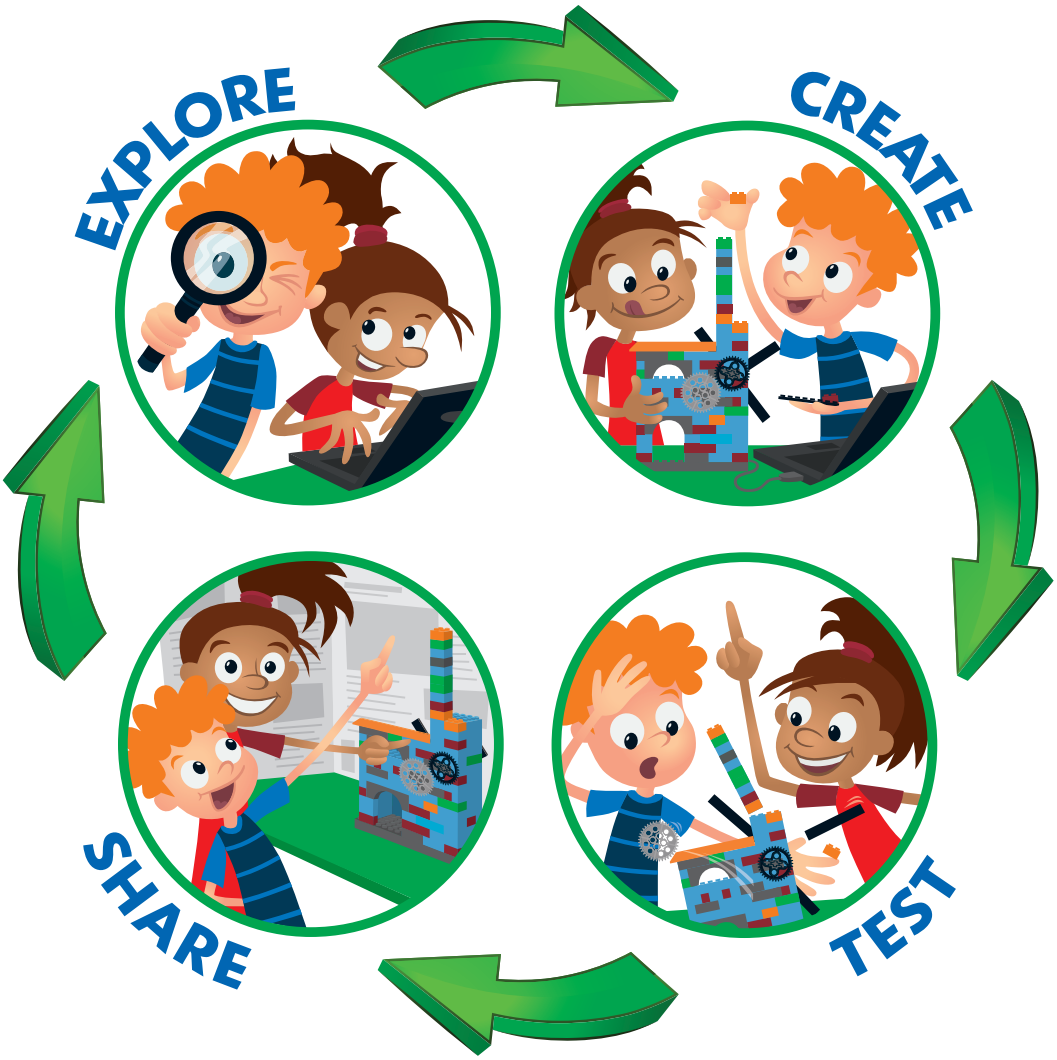
What is *FIRST*® LEGO® League Jr.?

FIRST® LEGO® League Jr. is a fun STEM program for teams of two to six kids ages 6 to 10. STEM stands for **s**cience, **t**echnology, **e**ngineering, and **m**ath. Every year there is a new, exciting subject. We call it the "Challenge." As part of a *FIRST* LEGO League Jr. team, you will learn about the Challenge. Then you will design and build a Team Model to show what you have learned. Using LEGO® Education WeDo 2.0, you will program at least one motorized part of your model. You will also create a *Show Me* poster about your journey of discovery. All teams practice the *FIRST*® Core Values. These include innovation, inclusion, and teamwork. At the end of the season, teams come together to share ideas and have fun!



Your coaches will guide you through the Explore, Create, Test, and Share parts of the Challenge.

Mission MOON℠

Come with us to live on the Moon!

Explore!

What do you need to know about the Moon to live there? What will you eat and drink? How will you get energy? How will you breathe? What will you do for fun? What other problems will you have to solve?

Create and Test!

Design and build a Moon Base. Use the LEGO® rocket ship and other elements from the Inspire Set to help you. Show your ideas for how to solve one or more of the problems you explored. Also be sure to use LEGO® Education WeDo 2.0 to build and program at least one motorized part of your Moon Base.

Share!

Make a *Show Me* poster. Use it and your Moon Base to share what you have learned with others. Participate in an Expo, invite your family and friends to a special team meeting, or share your *Engineering Notebook* to show what you know about living on the Moon!

SESSION 1: Name Your Team

Welcome to MISSION MOON℠! Are you ready to fly into the future? And blast off into outer space? You and your team are going to live on the Moon!

What do you know about the Moon? What else do you need to know to help you live there? What will you eat and drink? How will you get energy? How will you breathe? What other problems will you have to solve?

Your team will explore these questions. You will create a Moon Base and *Show Me* poster about what you learn. Then you will share your work. Throughout it all, your team must always honor the *FIRST*® Core Values.

FIRST® Core Values

- **Discovery:** *We explore new skills and ideas.*
- **Innovation:** *We use creativity and persistence to solve problems.*
- **Impact:** *We apply what we learn to improve our world.*
- **Inclusion:** *We respect each other and embrace our differences.*
- **Teamwork:** *We are stronger when we work together.*
- **Fun:** *We enjoy and celebrate what we do!*

Mini-Build 1: What is something you do well that will help your team?

Mini-Build 2: What is your idea for a team name?

What name did your team choose?

Draw your ideas for a MISSION MOON patch:

SESSION 2: Rocket Ship to the Moon

It's the year 2050. Scientists still have a lot to learn about the Moon. Your team was chosen to live and explore there. Your rocket ship was built to take you there. You have just landed!

You will find that the Moon is very different from Earth. There is no air to breathe. There is no water to drink. There is no food to eat. There are no homes to live in. There are no lights to turn on.

You can stay in your rocket ship for a little while. But soon you will need a better place to live. You must build a Moon Base!

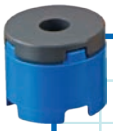
Your rocket ship has some supplies to help you. They are in four colored containers. Each color stands for something you will need on the Moon. Blue is for water. Yellow is for energy. White is for air. Green is for other things you might need.

Think about what could be inside each container. Be creative! How could these things help you live on the Moon?

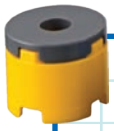
Mini-Build: What is one thing you would like to bring to the Moon?

Group 1: Build your LEGO® rocket ship!

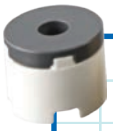
Group 2: What could be inside each supply container? How could these supplies help you live on the Moon? Build a model that shows your ideas.



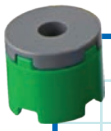
Water



Energy



Air



Other:

SESSION 3: Be an Engineer

Every mission to the Moon needs **engineers**. They design solutions to problems: *How will you get to the Moon? How will you land once you get there? What kind of toilet will work best on the Moon?*

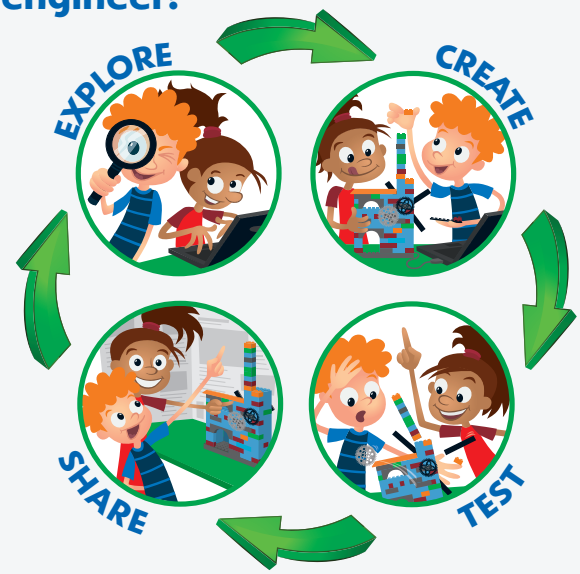
© NASA

You are an engineer, too! You and your team can use the **engineering design process** to help you solve problems. It has four main parts: *explore*, *create*, *test*, and *share*. It is okay to do a part more than once. And the parts do not have to go in order. They can go in a circle!

Practice being an engineer!

Explore a problem.

- Supplies for your Moon Base are inside your LEGO® rocket ship. After you land, you must get the supplies out. Then you must:
  1) Move the supplies away from the rocket ship.
  2) Keep them safe until you need them.



Create one or more solutions.

- Design a way to move the supplies away from the rocket ship.
- Design a safe place to store the supplies.
- Use only LEGO elements.
- Do not touch the supplies with your hands.

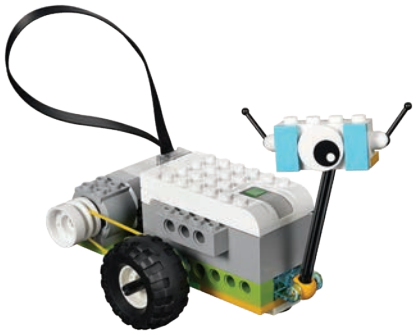
Test the solutions.

- How well do your solutions work?
- Can you think of ways to make them better?

Share what you learn.

Practice being an engineer!

Group 1: How will you move the supplies away from the rocket ship? Build and program a model that shows your solution. Try the model and program below, or design your own.



Milo

Program your model to move forward.

Group 2: How will you safely store the supplies? Build a model that shows your solution.

Groups 1 and 2: Record your ideas below. Which of your solutions worked best?

SESSION 4: Water on the Moon

Do you like to splash in puddles? Or drink from a water fountain? Or swim in a lake? You cannot do any of these things on the Moon. It has no liquid water at all!

All living things need water. We use it to drink, grow food, clean, and have fun. How will you get the water you need to live on the Moon? Below is one idea.

You could look for frozen water. You might find some ice deep under the ground. You might also find ice in some **craters**. Craters are the bowl-shaped holes on the Moon's surface. You could look for ice in the bottoms of big craters at the north and south poles. Once you find ice, you will have to melt it so you can use it.

Can you think of any other ideas?

Where will you look for water? How will bring the water to your Moon Base? How will you store it? How will you use it?

Let's explore water on the Moon!

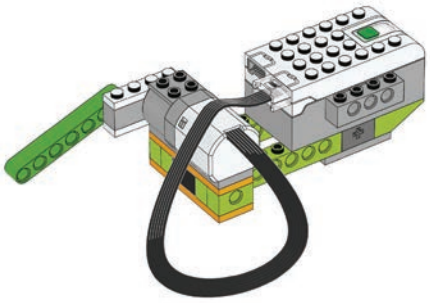
Did you know?

Craters on the Moon form when objects from outer space hit the surface at high speeds. Some of the Moon's craters are tiny. Some are huge. The big ones have names. Most are named after scientists and explorers.

© NASA

Mini-Build: What is one way that you use water?

Group 1: Build and program a model that shows how you will look for water on the Moon. Try the model and program below, or design your own. How will your model help you look for water?



Crank

Program your model to spin.

Group 2: How will you get any water you find back to your Moon Base? How will you store it? How will you use it? Build a model that shows your ideas.

Groups 1 and 2: Record your ideas below.

SESSION 5: Energy on the Moon

It can come from the sun. It can help you run. It makes cars go. It helps plants grow. What is it? It's **energy**!

Energy is what makes things move or work. It helps us do so many things! Grow food. Warm up. Cool off. Charge cell phones. Light our homes.

Think of all the ways you might use energy on the Moon. Where will you get the energy you need? Below is one idea.

You could use **solar panels**. They collect energy from sunlight. Days on the Moon can be very hot and sunny. Solar panels would work well during the day. You could use batteries to store the energy you collect. Then you could use it when you need it — even at night when it is cold and dark.

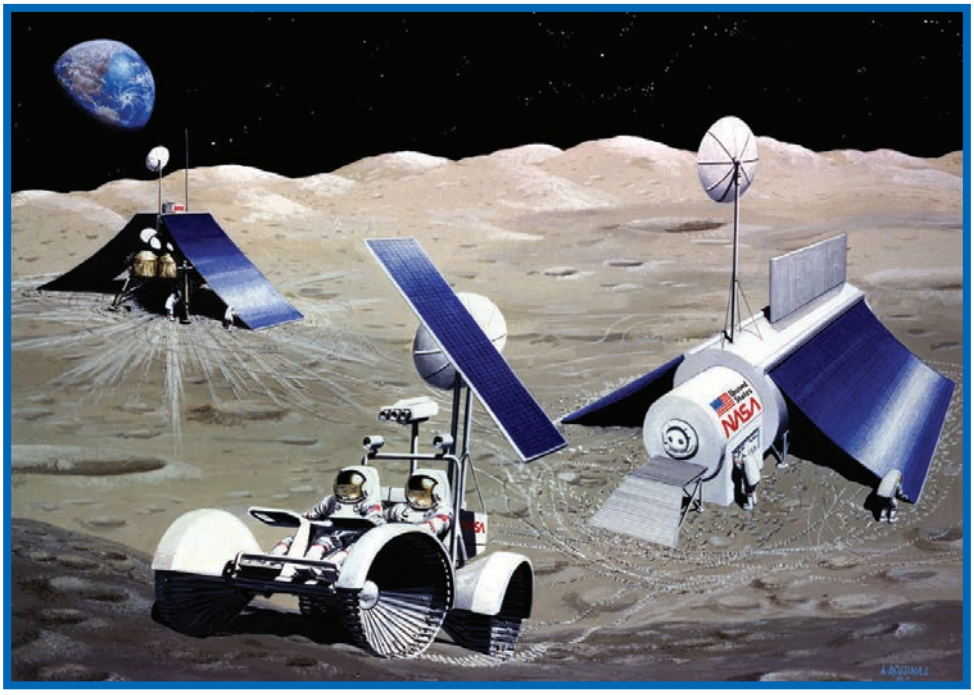
Can you think of any other ideas?

How will you get energy for your Moon Base? How will you store it? How will you use it?

Did you know?

Days and nights last a long time on the Moon. One Moon-day is about as long as 14 days on Earth! Each Moon-night is just as long.

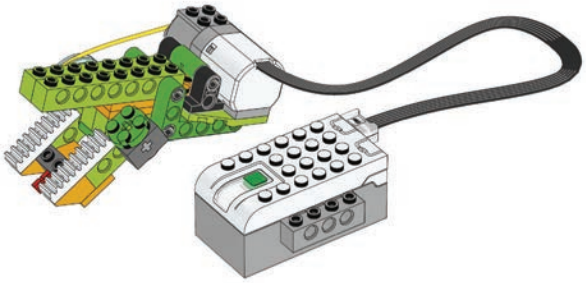
Let's explore energy on the Moon!



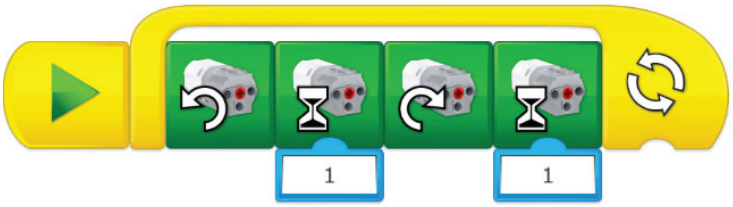
© NASA

Mini-Build: What is one way that you use energy?

Group 1: Build and program a model that shows one way you will use energy on the Moon. Try the model and program below, or design your own. How will your model help you on the Moon?



Grab



Program your model to open and close.

Group 2: How will you get energy for your Moon Base? How will you store it? How will you use it? Build a model that shows your ideas.

Groups 1 and 2: Record your ideas below.

SESSION 6: Air on the Moon

Take a deep breath. Now let it out. You do this thousands of times a day. But you probably do not think much about it. On the Moon, you will need to plan for every breath you take!

There is no air on the Moon like there is on Earth. Our air is a mix of many gases. One of the most important is **oxygen**. You can't see, smell, or taste it. Yet nearly all living things need oxygen. That includes us! We must breathe it in to stay alive.

You can bring some oxygen with you on your rocket ship. But you will need to get more after you land. How will you do this? Below is one idea.

The Moon's surface is covered with a thick layer of dust and bits of rock. There is a lot of oxygen trapped inside the dust and rocks. You could use a robot to help get it out.

Can you think of any other ideas?

How will you get air for your Moon Base? How will you keep it inside? What will happen if the air starts to leak out? Will you have an alarm to tell you if there is a problem? How will you breathe when you go outside?

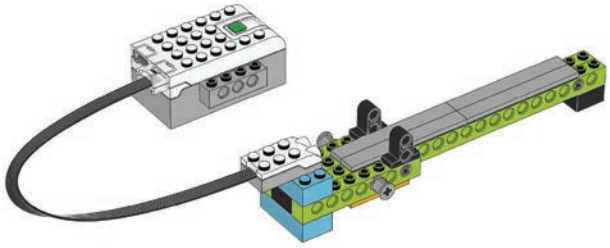
Did you know?

The layer of dust and loose rock on the Moon is called **regolith**. In some places, it can be up to 50 feet deep!

Let's explore air on the Moon!

Photos © NASA

Group 1: Build a model of an alarm for your Moon Base. Try the model and program below, or design your own. How could you use your alarm to warn people if air starts leaking out of your Moon Base?



Motion

Program your model to play a sound when it detects motion.

Tips from the Program Library

Do you want your alarm to light up? Try the "3a. Blink" program from the Program Library. Then program your alarm to blink in a different color.

Do you want your alarm to repeat a noise? Try the "4a. Alarm" program from the Program Library. Then record your own alarm sound or message.

Group 2: How will you get air for your Moon Base? How will you keep it inside? How will you breathe when you go outside? Build a model that shows your ideas.

Groups 1 and 2: Record your ideas below.

SESSION 7: Solving Problems on the Moon

Living on the Moon is not easy! You will need water, energy, and air. But these are not the only problems you will have to solve.

What will you eat? What will you do in your free time? How will you get around? How will you talk with your friends and family back on Earth? What other problems could you face?

Pick one problem to explore. Try to find a **solution**. The supply containers from your LEGO® rocket ship can help you. Remember those? Blue is for water. Yellow is for energy. White is for air. Green is for other things you might need.

Think about what might be inside the green container. Food to eat? Books to read? Games to play? A **lunar rover** to get around? A **satellite dish** to keep in touch with people back home? A **3D printer** to make tools and supplies? It's up to you!

Space images © NASA

Mini-Build: What do you like to do for fun?

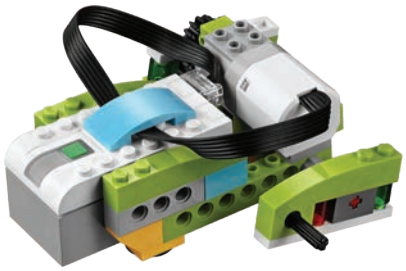
What will you eat on the Moon?

What will you do in your free time?

How will you get around?

What other problems could you face?

Group 1: Build and program a model to show a solution to a problem that you might face on the Moon. Try the model and program below, or design your own. How could your model help solve the problem you chose?



Walk

Program your model to move forward.

Group 2: What could be inside the green container from your rocket ship? How could it help solve a problem that you might face on the Moon? Build a model that shows your ideas.

Groups 1 and 2: Record your ideas below.

SESSIONS 8 and 9: Create Your Moon Base

It's time to create your Moon Base! It should show everything you have learned during the MISSION MOON℠ season.

Your Moon Base should...

- ☐ Show how you will get and use **at least** one of these:
  - Water
  - Energy
  - Air
- ☐ Show your solution(s) to any other problem(s) that you explored
- ☐ Be made of only LEGO® elements
  - You may use LEGO bricks, minifigures, baseplates, and other elements.
  - You may **NOT** use glue, paint, or any other art supplies.
- ☐ Include the LEGO rocket ship
- ☐ Have at least one motorized part programmed with LEGO® Education WeDo 2.0
- ☐ Be no more than 30 in. (76 cm) long and 15 in. (38 cm) wide

Make a plan. Then start building!

Mini-Build: What should a mini-map of your Moon Base show?

How will you get and use water, energy, and/or air?

Water: _____

Energy: _____

Air: _____

Did you explore any other problem(s)? How will you show your solution(s)?

Problem(s): _____

Solution(s): _____

How will you include the LEGO rocket ship?

_____

What part will you motorize and program?

_____

Draw a design for your Moon Base:

SESSIONS 10 and 11: Make Your *Show Me* Poster

You have learned so much! Now it is time to share what you know. You will start by making a ***Show Me* poster**.

Your poster should have three main parts: *Explore, Create and Test,* and *Share*.

- **Explore:** What did you learn this season? How did you learn it?
- **Create and Test:** How did you create your Moon Base and WeDo 2.0 program? How did you test them? How did you make them better?
- **Share:** What do you want to share about your team?

You can use words, drawings, and photos on your poster. You can also attach small objects. Below are some ideas of what you could include in each part of your poster.

Our Team

My name is _____

My favorite part of MISSION MOON℠ was _____

_____

One thing I learned is _____

_____

For fun I like to _____

The questions below can help you with the other parts of your poster.

Explore

Living on the Moon

- What did you learn about living on the Moon?
- How did you get answers to your questions?
- Is there anybody you should thank for helping you? If so, whom?

Water, Energy, and Air

- Why are water, energy, and air important?
- How will you get them on the Moon?
- How will you use them on the Moon?

Other Problems and Solutions

- What other problems could you face on the Moon?
- Which problem(s) did you explore?
- How did you try to solve the problem(s)?
- How will your solution(s) help you live on the Moon?

Create and Test

Our Moon Base

- What does your Moon Base show?
- How did you create it?
- Which part is motorized?
- Why did you choose to make this part move?

Our WeDo 2.0 Program

- What does your program do?
- How did you create it?
- How did you test it?
- How did you improve it?

SESSION 12: Prepare to Share

There are many ways to share what you have learned. You might:

- **Take part in a *FIRST*® LEGO® League Jr. Expo.**
  This is an event where teams share their work. Your family and friends can come, too. You will display your Moon Base and *Show Me* poster. You will also talk with *reviewers*. Reviewers are volunteers who will ask friendly questions about your work. They are not judges. They just want to hear about what you have learned. Everyone will get an award at the end of the Expo!

- **Invite your family and friends to a special team meeting.**
  Display your Moon Base and *Show Me* poster. Tell how you made them. Explain how your program works. Share what you have learned. Let your guests ask questions. When you are done, celebrate with high-fives!

Practice Presentation Questions

The questions below will help you think about what you would like to share.

- What is your team name? Why did you choose it?
- What has been your favorite part of being on your team?
- Did your team design a mission patch? If so, what does it show?
- What did you learn about living on the Moon?
- How did you learn about living on the Moon?
- How will you get water, energy, and/or air on the Moon?
- How will you use water, energy, and/or air on the Moon?
- What other problems could you face on the Moon? Which problem(s), if any, did your team explore?
- What solution(s) did your team find for any problem(s) that you explored? How could your solution(s) help you live on the Moon?
- What does your Moon Base show?
- How did you include the LEGO® rocket ship in your design?
- Which part of your Moon Base is motorized? Why did you choose to make this part move? How does your WeDo 2.0 program make this part move?
- What is your favorite part of your WeDo 2.0 program?
- What is your favorite part of your Moon Base?
- What is the most interesting thing you learned about the Moon?
- Did anything that you learned surprise you? If so, what?
- Would you like to live on the Moon some day? Why or why not?
- Is there anything else you would like to share?

Write Your Own Questions

1) _____

_____

2) _____

_____

3) _____

_____

LEGO® Education WeDo 2.0 Programming Blocks

Flow Blocks

Start Block
When used, always placed at the beginning of a program string. Press on it to start the program string you have written.

Start On Message Block
When used, always placed at the beginning of a program string.
It will wait for the correct message and then start the program string you have written.

Send Message
Sends a message to the Programming Canvas. Every Start On Message Block with the same message will be activated. The message can be in the form of text or numbers.

Wait For
Use this block to tell the program to wait for something to happen. It can wait for a set amount of time or for input from a sensor. This block always requires input in order to work properly.

Repeat Block
Use this block to repeat actions.
Blocks placed inside the Repeat Block will be looped. This can also be called the "loop block." The loop can be repeated forever, for a certain amount of time, or until something happens.

Start On Key Press Block
When used, always placed at the beginning of a program string. Press on it, or on the correct letter on the keyboard to start the program string you have written. All of the program strings with the same letter will start at the same time.
To change the letter of activation, long press on the block to get access to the keyboard.

Motor Blocks

Motor This Way Block
Sets the motor to turn the axle in the direction shown and starts the motor. Tap on the block to quickly change the direction of the rotation.

Motor That Way Block
Sets the motor to turn the axle in the direction shown and starts the motor. Tap on the block to quickly change the direction of the rotation.

Motor Power Block
Sets the motor power to the specified level and starts the motor. The level can be set with a numeric input from 0 to 10.

Motor On For Block
Starts the motor for a chosen amount of time specified in seconds. The amount of time can be set with a numeric input, using whole or decimal numbers.

Motor Off Block
Stops any movement of the motor.

LED Blocks

Light Block
Lights up the LED on the Smarthub in a specific color. The color can be changed with a numeric input between 0 and 10.

Sound Blocks

Play Sound
Plays a sound. The sound is chosen from a list available within the software.
You can choose a sound using a numeric input. Choose sound number 0 to play a sound that you have recorded yourself.

Display Blocks

Display Background
Use this block to display an image chosen from a list available within the software.
You can set an image using a numeric input.

Display Block
Use this block to open the display area on the software screen. Numbers or text will appear in the display area.

Add to Display
Adds a quantity to the number currently shown on the display. Enter the number you wish to add. Tap on the block to change the mathematical operation.

Subtract from Display
Subtracts a quantity from the number shown on the display. Enter the number you wish to subtract. Tap on the block to change the mathematical operation.

Multiply Display
Multiplies the number shown on the display by a specified number.
Enter the number you wish to multiply by.
Tap on the block to change the mathematical operation.

Divide Display
Divides the number shown on the display by another number. Enter the number you wish to divide by. Tap on the block to change the mathematical operation.

Display Closed
Use this block to close the display area on the software screen.
Tap on the block to change the size.

Display Medium Size
Use this block to set the display area to medium size.
Tap on the block to change the size.

Display Full Size
Use this block to set the display area to full size. Tap on the block to change the size.

Sensors Inputs

Any Distance Change
Inputs the Motion Sensor mode “Any Distance Change” to a block.

Distance Change Closer
Inputs the Motion Sensor mode “decreasing distance between the sensor and an object” to a block.

Distance Change Further
Inputs the Motion Sensor mode “increasing distance between the sensor and an object” to a block.

Shake
Inputs the Tilt Sensor mode “Shake” to a block.

Tilt Down
Inputs the Tilt Sensor mode “Tilt Down” to a block.

Tilt Up
Inputs the Tilt Sensor mode “Tilt Up” to a block.

Tilt That Way
Inputs the Tilt Sensor mode “Tilt That Way” to a block.

Tilt This Way
Inputs the Tilt Sensor mode “Tilt This Way” to a block.

Tilt Sensor No Tilt
Inputs the Tilt Sensor mode “No Tilt” (or horizontal position) to a block.

Distance Sensor Input
Inputs the value detected by the Motion Sensor (from 0 to 10) to a block.

Numeric and Text Inputs

Sound Sensor Change
Inputs the Sound Sensor (from the device) mode “sound level change” to a block.

Number Input
Inputs a numeric value to a block.

Text Input
Inputs a text value to a block.

Display Input
Inputs the numeric value shown on the display area to a block.

Random Input
Inputs a random value to a block.
The range of numbers is determined by the block to which it is attached.

Other Blocks

Bubble
Use the bubble to insert comments into your program. This is not a programming block.

Glossary

3D printer
A machine that creates three-dimensional objects by building them one layer at a time

air
A mixture of gases, including oxygen, that surrounds Earth and that people and animals breathe; you cannot see, smell, or taste air

airlock
A small room that people can use to move between two places with different air pressures; the room has an airtight door to each place, but only one door is allowed to be open at a time

core values
Guidelines that help people know how to act; the Core Values of *FIRST*® are: Discovery, Innovation, Impact, Inclusion, Teamwork, and Fun

crater
A bowl-shaped hole created by something hitting a surface; craters on the Moon form when objects from outer space hit the Moon's surface at high speeds

energy
The ability to make things move or work; all energy is either kinetic (moving energy) or potential (stored energy); energy cannot be created or destroyed, but it can change from one form to another

engineer
A person who designs solutions to problems

engineering design process
The steps that an engineer uses to design a solution to a problem: Explore a problem; Create one or more solutions; Test the solutions; Share what you learn

***FIRST*® LEGO® League Jr. Expo**
An event where *FIRST*® LEGO® League Jr. teams come together to share what they learned during the Challenge season; each team presents its Team Model and *Show Me* poster to volunteers called *reviewers*, and each team member gets an award

Inspire Model
A Challenge-specific model made of LEGO® elements that is included in the Inspire Set and that must be incorporated into the Team Model; the Inspire Model for MISSION MOON℠ is a LEGO rocket ship

Inspire Set
A Challenge-specific LEGO® Education set containing about 700 LEGO elements that a team can use to build its Team Model

lunar rover
A vehicle used by astronauts to drive on the Moon's surface

moon base
A building on the Moon where astronauts can live and work; the Team Model for MISSION MOON is a Moon Base

motor
A machine that can be used to make something else move

motorize
To give something a motor to make it move

oxygen
A gas that nearly all living things need to survive

prototype
A model of something that can be used to test an idea

regolith
The layer of dust and loose rock on the surface of the Moon

satellite dish
A bowl-shaped antenna that sends information to and/or receives information from a satellite orbiting Earth, the Moon, or another planet or moon

***Show Me* poster**
The poster that a *FIRST* LEGO League Jr. team creates to show what they learned and accomplished during the Challenge season

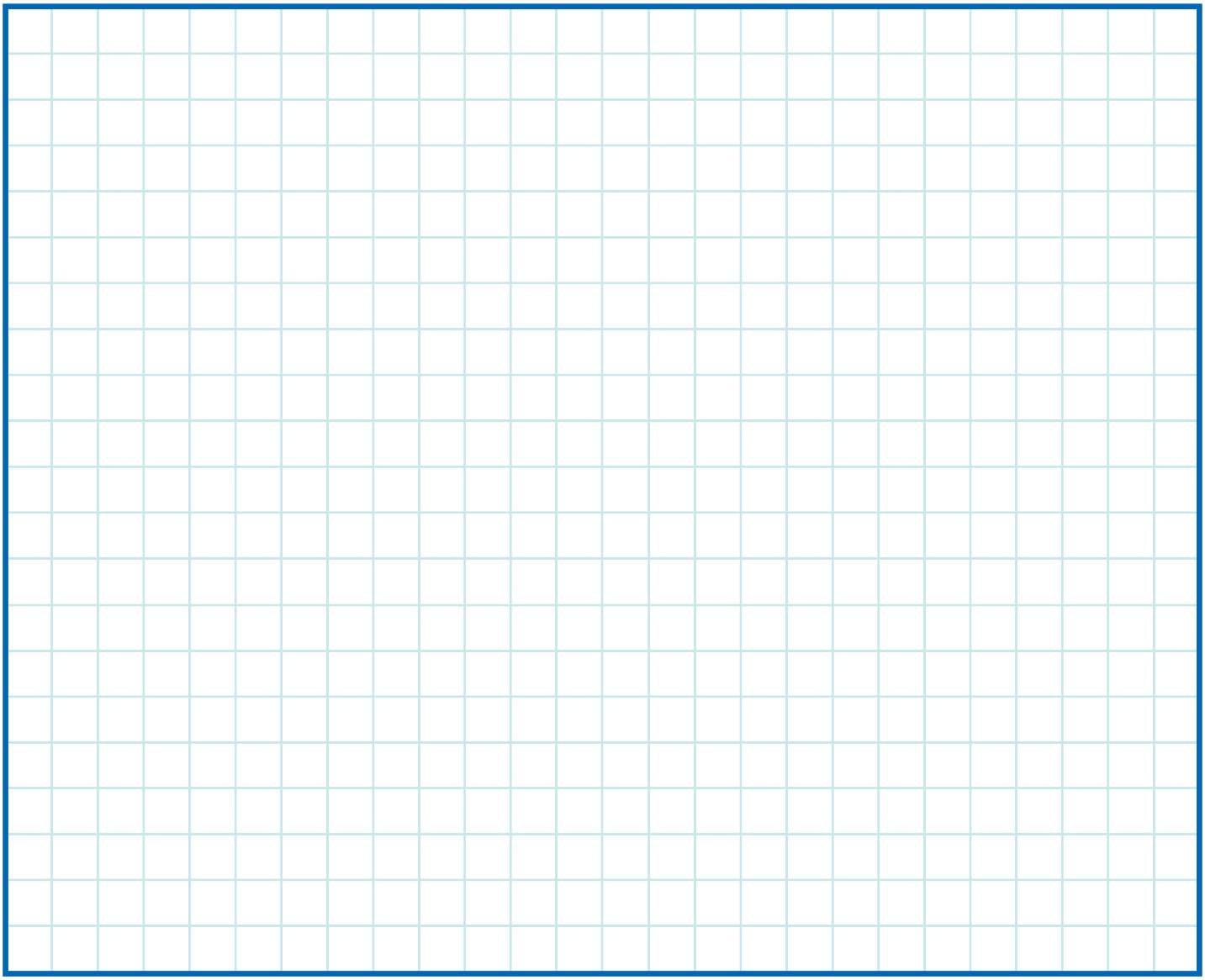
solar panel
A device that captures energy from sunlight and changes it into energy that people can use

solution
A way to solve a problem

Team Model
The model that a *FIRST* LEGO League Jr. team designs and builds using LEGO elements to show what they learned during the Challenge season; it must include the Challenge-specific Inspire Model and at least one motorized part programmed with LEGO Education WeDo 2.0; the Team Model for MISSION MOON is a Moon Base

Notes and Drawing Area

Notes and Drawing Area



Notes and Drawing Area

Notes and Drawing Area

Name: _____

Team Name: _____

FIRST® LEGO® LEAGUE JR.

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