

**FIRST[®]
LEGO[®]
LEAGUE JR.**

**ENGINEERING
NOTEBOOK**



AQUA
ADVENTURESM



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LEGO[®]
LEAGUE JR.**

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NOTEBOOK**

AQWA
ADVENTURESM





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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](https://twitter.com/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.

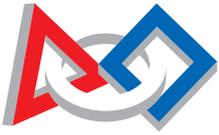


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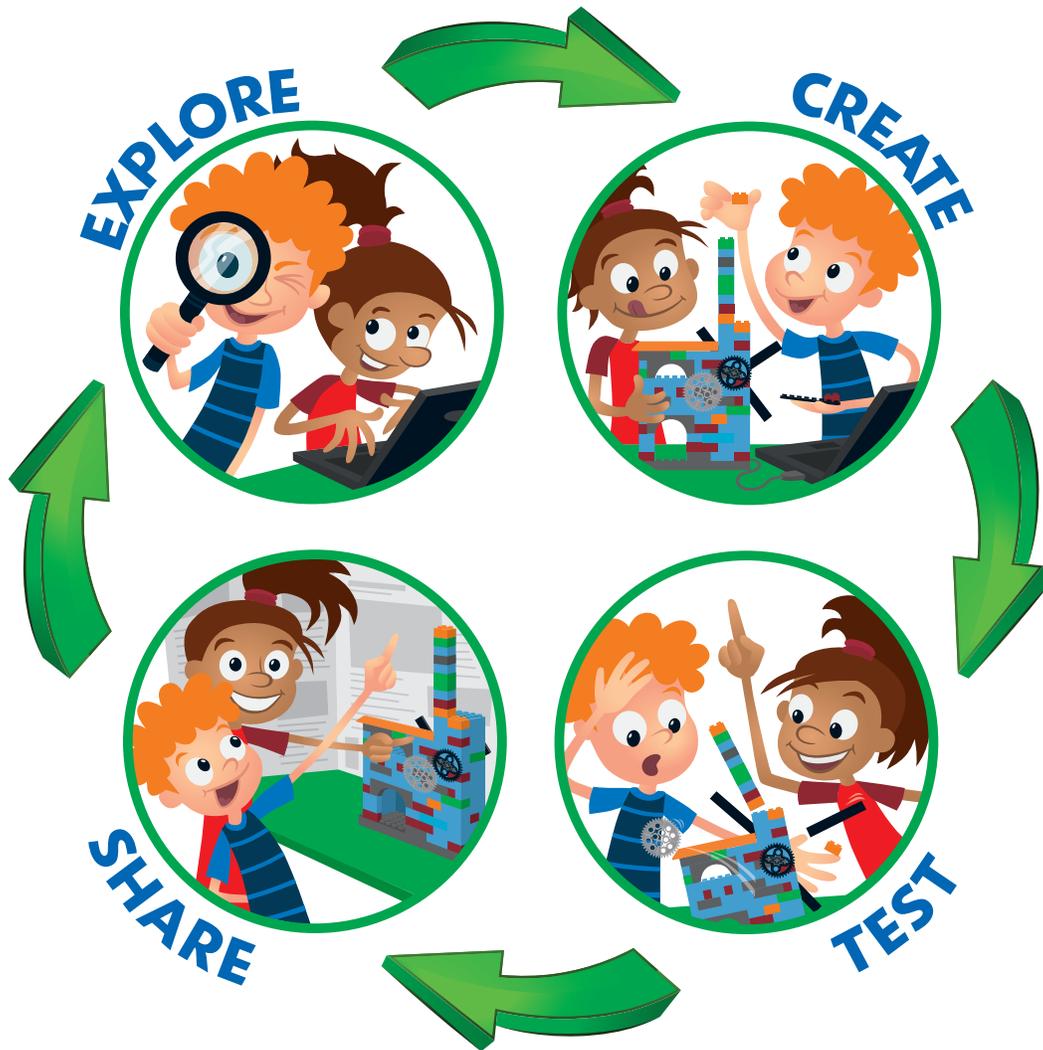
What is **FIRST**® **LEGO**® League Jr.?



FIRST
LEGO
LEAGUE JR.

FIRST® *LEGO*® League Jr. is a fun STEM program for teams of two to six kids ages 6 to 10. STEM stands for science, technology, engineering, and math. 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, 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* LEGO League Jr. Core Values. These include respect, sharing, 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.



AQUA ADVENTURESM Challenge

AQUA ADVENTURESM

In the *FIRST*[®] LEGO[®] League Jr. AQUA ADVENTURESM Challenge, you will:

- **Explore** how you use water at home or in your community, the water's journey, and how to improve a part of this journey.
- **Create and test** a Team Model to show your ideas.
- **Share** what you learn through your Team Model and a *Show Me* poster.

Hi, I'm Hydro the water drop! Find out how water like me gets to you. Can you help make my journey better?



**Join me on an
AQUA ADVENTURE!**

Explore!

You and your community use water for many things every day. Where does your water come from? How does it get to you? Is the water cleaned or treated before you can use it? Why is it important to use water wisely? **Pick one way that you use water at home or in your community. Learn as much as you can about the water's journey. Then design a solution to improve a part of this journey.**

Create and Test!

Design, build, program, test, and improve a Team Model to show your chosen water use, the water's journey, and your idea for how to improve a part of the journey. Include the AQUA ADVENTURE Inspire Model (a LEGO[®] water pump) in your design. Also be sure to use LEGO[®] Education WeDo 2.0 or WeDo to build and program at least one motorized part of your Team Model.

Share!

Make a *Show Me* poster, and use it and your Team Model 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 water.

No matter what you do, have fun!



SESSION 1: Name That Team!



Welcome to *FIRST*® LEGO® League Jr.! This season, you and your team will work on the AQUA ADVENTURESM Challenge. You will start by exploring how important water is in your life.



Then you will pick one of the ways that you use water at home or in your community. You will learn as much as you can about the water's journey. Where does the water come from? How does it get to you? How much do you use? What happens after you use it?

As you follow the water's journey, you will look for any problems. For example, is there a problem with how the water gets to you? Or do you use more water than you need? You will choose one problem that you can help fix. Then you will design a solution to the problem.

You will build a Team Model and create a *Show Me* poster about what you learn. Finally, you will share your work with others.

At every session, you will honor the *FIRST* LEGO League Jr. Core Values:

- **We are a team.**
- **We do the work.**
- **Our Coaches help us learn, but we find the answers ourselves.**
- **We share our experiences and discoveries with others.**
- **We are helpful, kind, and show respect when we work, play, and share. We call this *Gracious Professionalism*®.**
- **We are all winners.**
- **We have fun!**





My favorite Core Value is

Draw a picture that illustrates your favorite Core Value:

A large rectangular area filled with a light blue grid, intended for drawing an illustration related to the favorite Core Value.

My team's name is

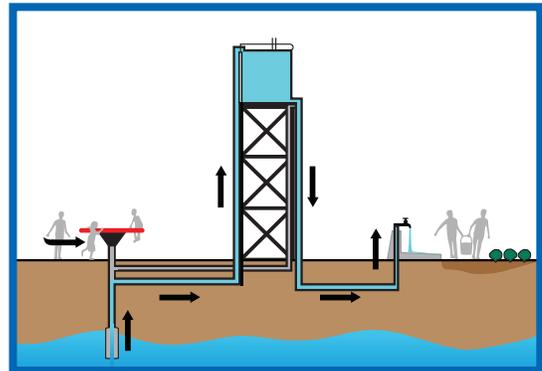


SESSION 2: The PlayPump Story



When you want water, how do you get it? Do you turn on a tap? Do you get it from a bottle? Do you use a pump? People in some places do not have any of these choices. They must get water another way. They might have to walk to a river or lake. This can take a long time. The water might not be clean. Water engineers visit these places to look for water that is nearby and clean. They drill deep holes into the ground. If they find water, they put in a pump to help people get the water.

In 1989, a water engineer in South Africa had an idea. He knew that some places needed water. He also knew that some schools did not have playgrounds. His idea was to attach a merry-go-round to a water pump. Children could use it to play at school and get water at the same time. A group of people liked this idea. They built a model of it and added more parts. They called it the PlayPump. As children spun on the merry-go-round, the pump got water from under the ground. The water went up into a tank. A tap let people get the water when they needed it.



The group built many PlayPumps. They put them in South Africa and other countries. Children had fun playing on them. People used the water to drink, wash hands, water gardens, and more. Children got sick less often. They were able to go to school more.

But PlayPumps were not perfect. Sometimes people who wanted water found an empty tank. They had to push the merry-go-round by themselves. When a PlayPump broke, it could take a long time to get parts to fix it. Some PlayPumps were replaced with hand pumps.

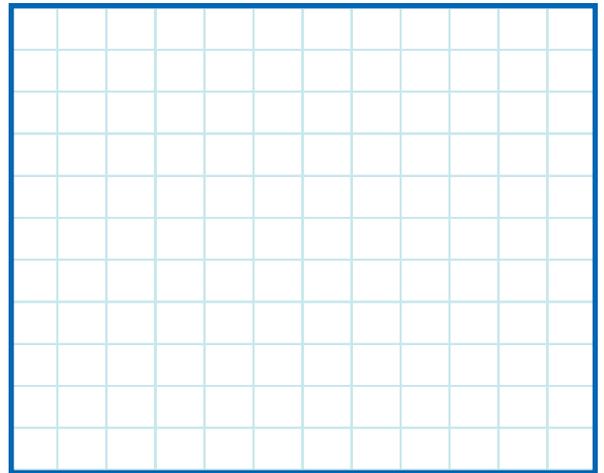
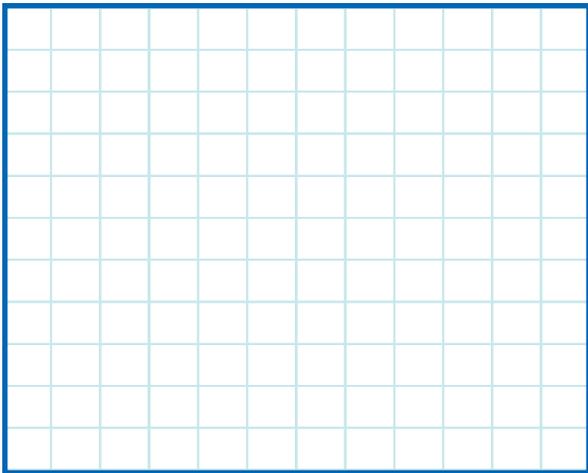
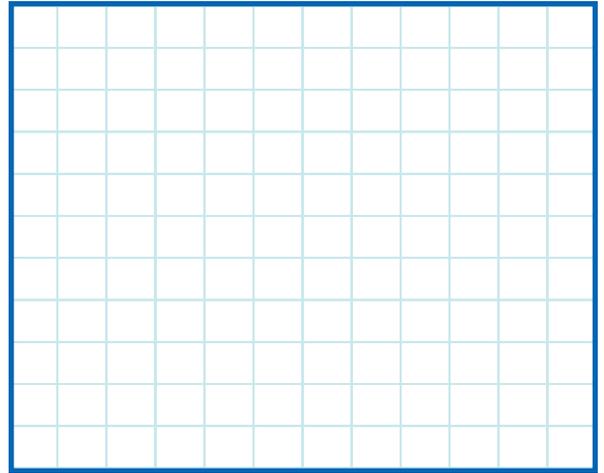
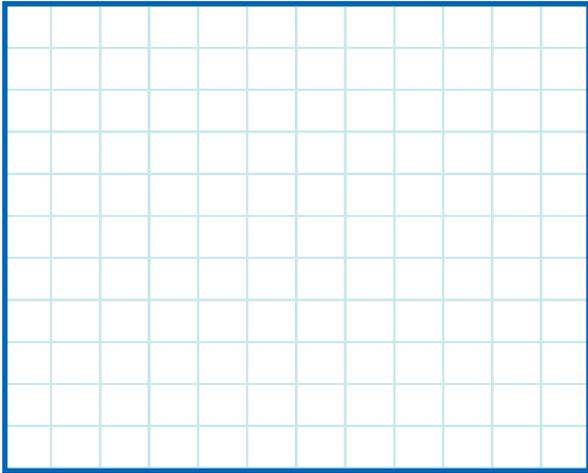
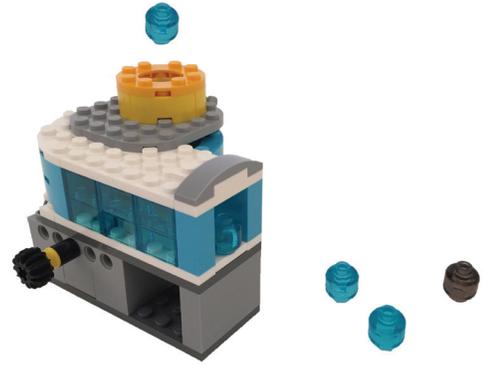


In 2008, a new group took over the PlayPump project. They knew about the problems. They have worked hard to solve them. When a PlayPump breaks, they fix it fast. They also put in new PlayPumps only if it makes sense. There must be a need for water. A PlayPump must be able to meet the need. And the local people must want a PlayPump.

Today there are more than 900 PlayPumps in South Africa. They help people get clean water, and they help children have fun!



What other models will you build to act out the PlayPump story?





SESSION 3: Choose Your Water Use



If you had to name the five most important things in your life, what would you say? Water might not be on your list. But without water, there would be no life at all! Every living thing on Earth needs water.

People use water for many things. We drink it. We use it to grow food. We use it to clean. We use it to play and have fun. Look at the list below. It shows just some of the ways that people use water at home and in their communities:

- boating
- brushing teeth
- cleaning
- cooking
- drinking
- fighting fires
- filling fish tanks
- filling fountains
- fishing
- flushing toilets
- generating electricity
- ice skating
- making art
- making ice
- making steam
- showering
- swimming
- taking a bath
- washing clothes
- washing dishes
- washing hands
- watering crops
- watering flowers
- watering grass

For the AQUA ADVENTURESM Challenge, your team will choose one way that you use water at home or in your community. Then you will learn as much as you can about how water gets to you for this use!

What water use will you choose?





Think about how you use water at home. Also think about how you use water in your community. Draw or write down as least two of your ideas for each place.

How I Use Water	
At Home	In My Community

Draw the water use that your team chooses for the AQUA ADVENTURE Challenge:

A large rectangular grid with a blue border and light blue grid lines, intended for drawing a water use scenario.

My team's water use is _____



SESSION 4: Follow Your Water's Journey



You chose a water use. Now it's time to learn how the water gets to you for that use! To begin, you must find the source of your water. That is, where does it come from? Under the ground? On Earth's surface? From the sky?

People in many places use groundwater. This is water found under the ground. It is in the spaces and cracks of underground layers of soil and rock. People use wells, pipes, and pumps to bring groundwater up to the surface. In some places, people use water that is already on Earth's surface. Rivers, lakes, and the ocean are examples of surface water. When water falls from the sky in the form of rain or snow, it can add to surface water. Water from the sky can also soak into the ground and make more groundwater. Sometimes people collect rain or snow as it falls. They might use it right away or store it for later.

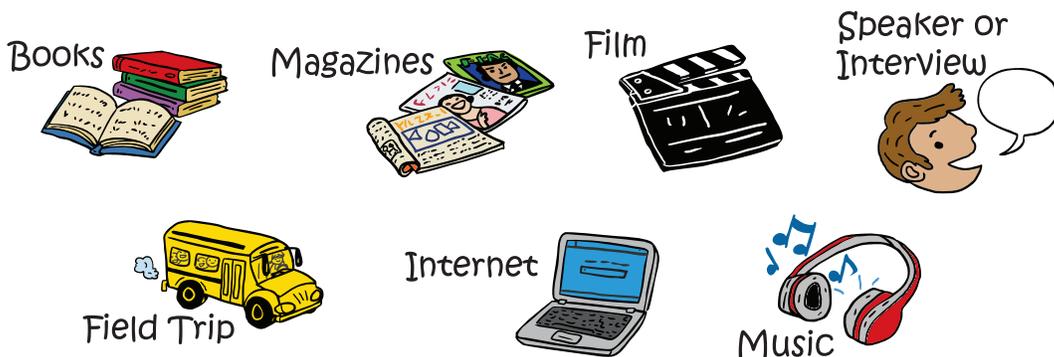
Water must often be cleaned before people can use it. Towns and cities help clean water at water treatment plants. Water treatment plants take sand, dirt, and trash out of the water. If the water is from the ocean, they take out salt, too. They kill any bacteria in the water. Then they use pipes, pumps, and other tools to send clean water to the community.



Where does your water come from?

Does your home or school have its own well? Does your town provide your water? Does the water get cleaned? If so, how? How far does the water travel? What kinds of pumps and pipes does it go through? Once it reaches you, do you use a tap to get it? Or do you get it some other way? What happens to the water when you are done with it?

Look at the pictures below. They show some ways you could learn more about water. You will need to do research so you can build a great Team Model and *Show Me* poster.



It's time to follow your water's journey!



My team's water use is _____

The source of the water for this use is *(circle one or more)*

groundwater stream river lake ocean reservoir rainfall snowfall

Other: _____

How does the water get from the source to you so that you can use it? Write or draw what you know and what you want to know about this in the KWL chart below. Later, add what you have learned.

My Water's Journey		
K (What I Know)	W (What I Want to Know)	L (What I Learned)

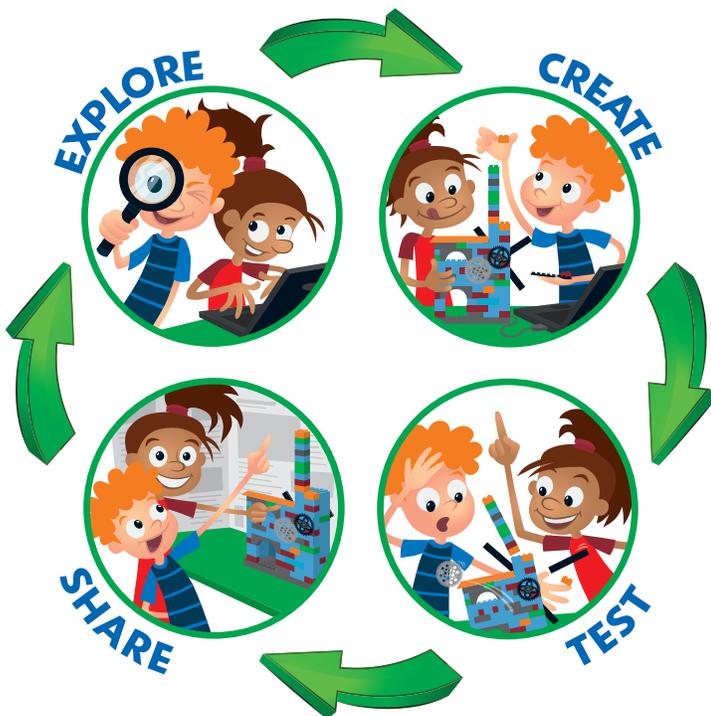


SESSION 5: Be an Engineer



Think back to the PlayPump story. The PlayPump started as an idea. Engineers worked hard to bring the idea to life. They had to solve some problems along the way.

How can a merry-go-round be used to pump water? What is the best way to collect the water? How should the water be stored? They tested many solutions. If one did not work, they tried a new one. They kept working to find the best solutions.



You are an engineer, too! All engineers use the engineering design process. The four main parts of this process are *explore*, *create*, *test*, and *share*. Sometimes you have to do a part more than once. And the parts do not always go in order. They can go in a circle!

Explore a problem. *Create* one or more solutions. *Test* the solutions. *Share* what you learn.

Practice being an engineer by solving a problem with your team. Look at the AQUA ADVENTURESM Inspire Model. What happens when the LEGO[®] water comes out of the pump? Imagine that you need to collect the water and store it to use later. But you must follow some rules.

- 1) You can use only LEGO elements.
- 2) You cannot touch the water with your hands once it comes out of the pump.
- 3) You must store the water at least 6 in. (15 cm) away from where it comes out of the pump.

Start by exploring the problem. Then create and test a solution. Can you think of any ways to make your solution better? Don't forget to share what you learn!





How will you collect the LEGO water that comes out of the pump?

A large square grid with a blue border and light blue grid lines, intended for drawing a collection method.

How will you store the water at least 6 in. (15 cm) away from the pump opening?

A large square grid with a blue border and light blue grid lines, intended for drawing a storage method.

Which of your team's solutions worked best?

A large square grid with a blue border and light blue grid lines, intended for drawing a comparison or final solution.



SESSION 6: Improve Your Water's Journey



You have done a lot so far as part of the AQUA ADVENTURESM Challenge! You chose a way that you use water at home or in your community. You learned how water gets to you for this use. Now it is time to take a closer look at your water's journey. What part of the journey could you make better?

Think about the beginning of your water's journey. What source does your water come from? Is this source the only place for you or your community to get water? If not, are there any sources that might be better?

Now think about the middle of the journey. How does your water get to you? Does it get cleaned along the way? What kinds of pipes does it travel through? Are they new or old? Does the water get stored anywhere before it comes to you? If so, are there any problems with how it is stored?

Also think about the end of the water's journey. How do you use the water? Is the water safe for this use? Could you make it safer? Do you ever use more water than you need? If so, how could you use less? And what happens to the water when you are done with it? Where does it go? Is this the best place for it to go?

Make a list of any problems you found with your water's journey. Your team must choose one of these problems to explore. Pick one that you can help fix. Then get ready to improve your water's journey!





SESSION 7: Plan Your Team Model



Think back to the start of this season. Did you know how much water you use? Or where your water comes from? Or how it gets to you? Or how you could improve its journey? You probably know much more now!

The next step of the AQUA ADVENTURESM Challenge is to create a Team Model to show everything you have learned. Today, you will plan this model. Start by learning the rules for building it:

- **Your Team Model must show your chosen water use, the journey that water takes to get to you for this use, and the solution you designed to improve the water's journey.**
- **You must use only LEGO® elements. You can use any LEGO bricks, minifigures, base plates, or other elements. You may not use glue, paint, or any other art or craft materials.**
- **You must include the AQUA ADVENTURE Inspire Model.**
- **You must use LEGO® Education WeDo 2.0 or WeDo to build and program at least one motorized part.**
- **The footprint of your Team Model must be no bigger than 30 in. x 15 in. (76 cm x 38 cm). There is no height limit. However, your team must be able to move the model safely.**
- **Use your imagination as you design and build. Be creative!**





How will you show your water use?

How will you show your water's journey?

How will you show the solution you designed to improve your water's journey?

How will you include the AQUA ADVENTURE Inspire Model?

What motorized, programmable part will you include?

Draw a design for your Team Model:

A large rectangular area filled with a light blue grid, intended for drawing a design for the team model.



SESSIONS 8 and 9: Build Your Team Model



You have worked hard on the AQUAADVENTURESM Challenge! You learned about water and its many uses. You chose one of these uses to explore. You learned about the water's journey. You looked for problems along the way. You asked questions and did research to get answers. You designed a solution to improve the water's journey. You built small models and programmed them to move. Now it is time to build a bigger model to show everything you have learned.

Today you will begin to build your Team Model. Remember to follow the building rules that you learned about in the last session. Use the design your team made to guide you as you build. But if something does not work, do not be afraid to change it. There are no right or wrong answers when it comes to building.

What are you waiting for? Start building, and have fun!





Water Use and Journey

Does your Team Model show your water use? **(circle one)** yes no

Does it show the water's journey? **(circle one)** yes no

Does it show your solution for improving the water's journey? **(circle one)** yes no

Does it include the AQUA ADVENTURE Inspire Model? **(circle one)** yes no

If you answered "no" to any of these questions, how could you improve your model?

Motorized Part and Program

Does a motor make at least one part of your model move? **(circle one)** yes no

Is the motor secure? **(circle one)** yes no

Does the program that runs the motor work the way you want it to? **(circle one)** yes no

If you answered "no" to any of these questions, how could you improve your motorized part and/or your program?

Draw a picture of one change you could make to improve your Team Model:



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

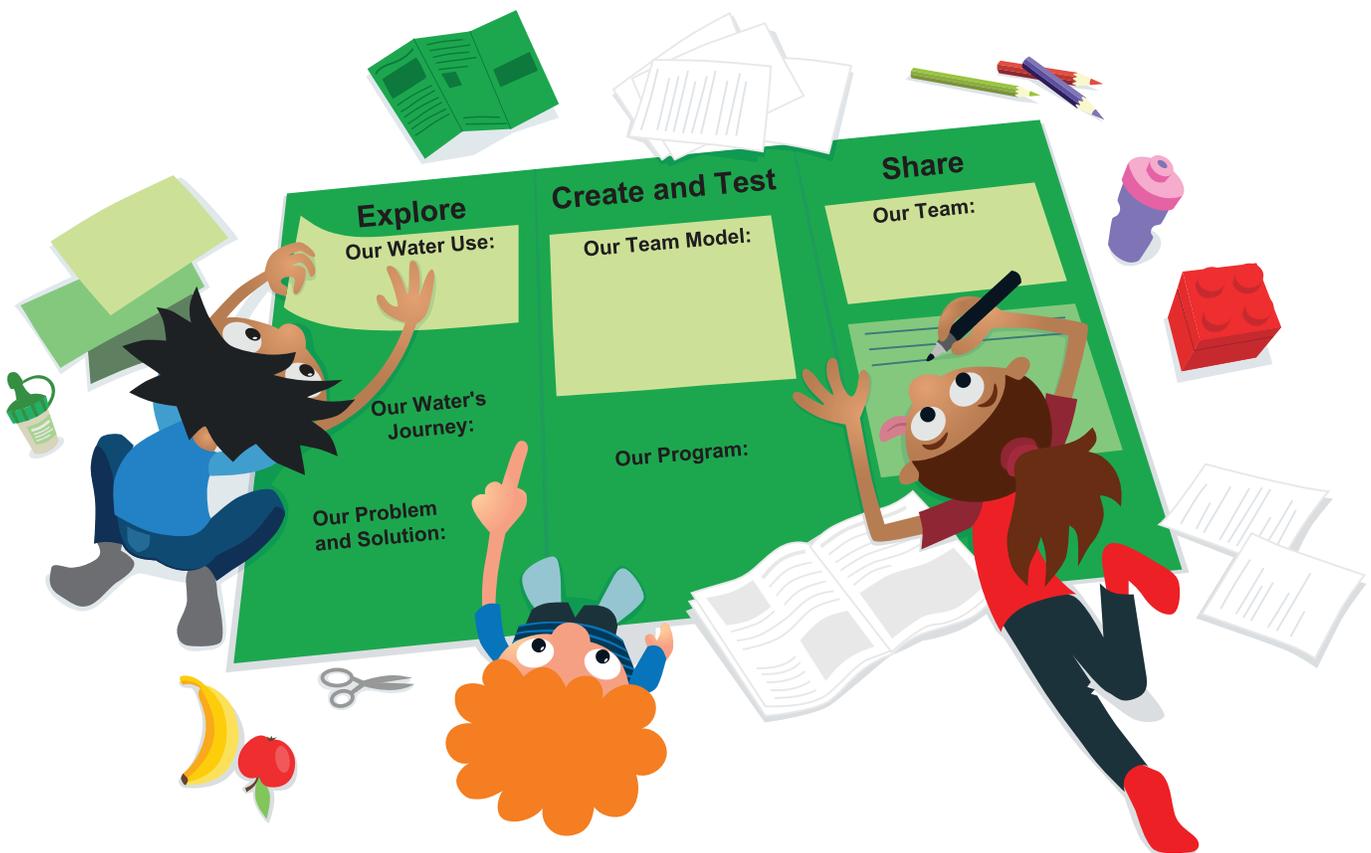


You have learned so much this season! Now it is time to share what you have learned so others can learn about it, too. You will start by making a *Show Me* poster.

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

- **Explore:** Explain what you learned this season and how you learned it.
- **Create and Test:** Tell how you created and tested your Team Model and program.
- **Share:** Share information 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 working on the AQUA ADVENTURESM Challenge was _____

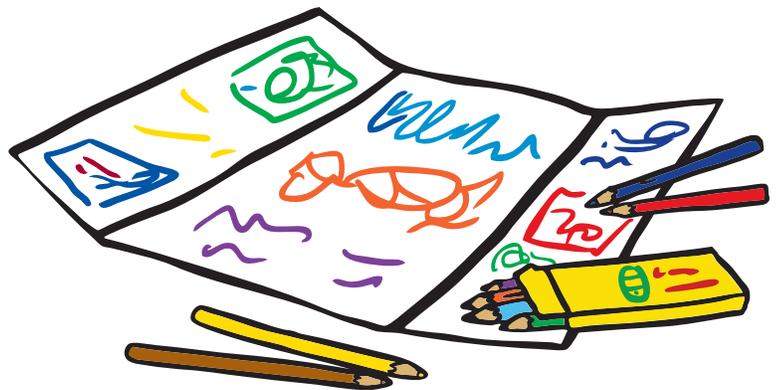
One thing I learned is _____

For fun I like to _____

Answer some or all of the questions below to help you with the other parts of the poster:

Our Water Use

- What water use did your team choose to explore?
- Why did you choose this water use?
- How did you learn more about it?
- What did you learn?
- Is there anybody you should thank for helping you with your research? If so, who?



Our Water's Journey

- How did you research your water's journey?
- What did you learn about how water gets to you for your chosen use?
- Is there anybody you should thank for helping you with your research? If so, who?

Our Team Model

- What does your Team Model show?
- How did you create it?
- What part is motorized?
- Why did you make this part move?
- How did you test it?
- How did you improve it?

Our Problem and Solution

- What problem did you find with your water's journey?
- What is your solution to this problem?
- How could your solution help improve your water's journey?

Our 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 your team has learned during the AQUA ADVENTURESM season. You could:



- **Participate in a *FIRST*[®] LEGO[®] League Jr. Expo.**

This is an event where you will talk with Volunteers called “Reviewers” and other teams. You can invite your family, friends, and others to come, too. You will share your Team Model and *Show Me* poster. Remember that the Reviewers at an Expo want to learn about what you have done. They are not there to make you nervous. This is your chance to show off your work and explain what you have learned. All team members will receive an award at the end of the Expo.

- **Invite your family and friends to a special team meeting.**

Display your Team Model and *Show Me* poster. Tell how you created them. Explain how your program works. Share what you learned. Let your guests ask questions. When you are done, high-five one another to celebrate the end of the season.

Whatever you do, have fun!





Practice Presentation Questions

- What is your team name, and why did you choose it?
- What has been your favorite part about being on your team?
- What water use did your team choose to learn more about?
- How does water get to you for this use?
- How did you get information about your water's journey?
- What problem(s) did you find with your water's journey?
- Which problem did you choose to explore?
- What is your team's solution to the problem you chose to explore?
- How did you come up with this solution?
- How could this solution improve your water's journey?
- What does your Team Model show?
- How did you include the AQUA ADVENTURE Inspire Model in your Team Model?
- What part of your Team Model is motorized?
- Why did you make this part move?
- How did you create the program to make this part move?
- What is your favorite part of your Team Model?
- What is your favorite part of your program?
- What is the most interesting thing you learned about water this season?
- Did anything that you learned surprise you? If so, what?
- Why is it important to use water wisely?
- Is there anything else you would like to share?

Write Your Own Questions

1)

2)

3)



Glossary

bacteria

Tiny living things made of one cell; they can live in soil, water, plants, animals, and other places; some can make people sick

core values

Guidelines that help people know how to act; the Core Values of *FIRST*® LEGO® League Jr. are: We are a team; We do the work; Our Coaches help us learn, but we find the answers ourselves; We share our experiences and discoveries with others; We are helpful, kind, and show respect when we work, play, and share — we call this *Gracious Professionalism*®; We are all winners; We have fun!

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 show 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

groundwater

Water found in spaces and cracks of underground layers of soil and rock

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

Inspire Set

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

journey

The act of traveling from one place to another

KWL chart

A chart that is divided into three sections for recording information; the “**K**” section stands for “*What I Know*,” the “**W**” section stands for “*What I Want to Know*,” and the “**L**” section stands for “*What I Learned*”

motor

A machine that can be used to make something else move

pulley

A machine that is a wheel with a groove on the rim, around which a rope or belt fits; can be used to raise, lower, or move something

reservoir

A lake or tank that is used to collect and store a large amount of water for people to use; can be natural or human-made

solution

A way to solve a problem

source

The starting point of something

surface water

Water that collects on Earth’s surface; includes rivers, lakes, and the ocean

tap

A tool that can be used to control the flow of water from a pipe or other container

Team Model

The model that a *FIRST* LEGO League Jr. team designs and builds using LEGO elements and that includes the Challenge-specific Inspire Model, at least one motorized part programmed with LEGO Education WeDo 2.0 or WeDo, and the team’s design solution based on the Challenge

water pump

A machine used to move water from one point to another; can be used to bring water up from under the ground

water treatment plant

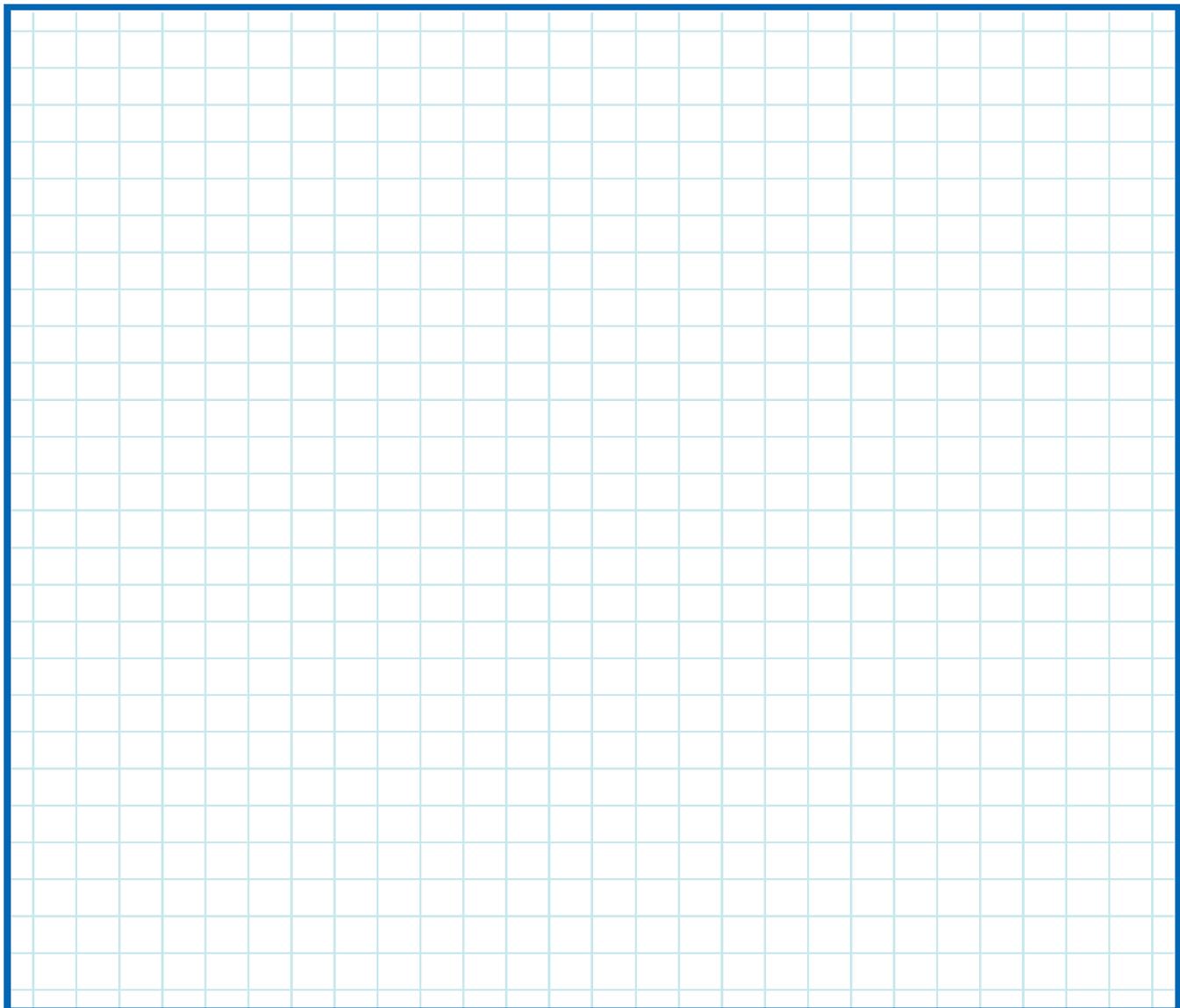
A place that cleans water by taking out anything harmful in order to make it safe for people to use and/or cleans water after people use it to make it safe to return to the environment

water well

A hole or structure created in the ground to let people get groundwater

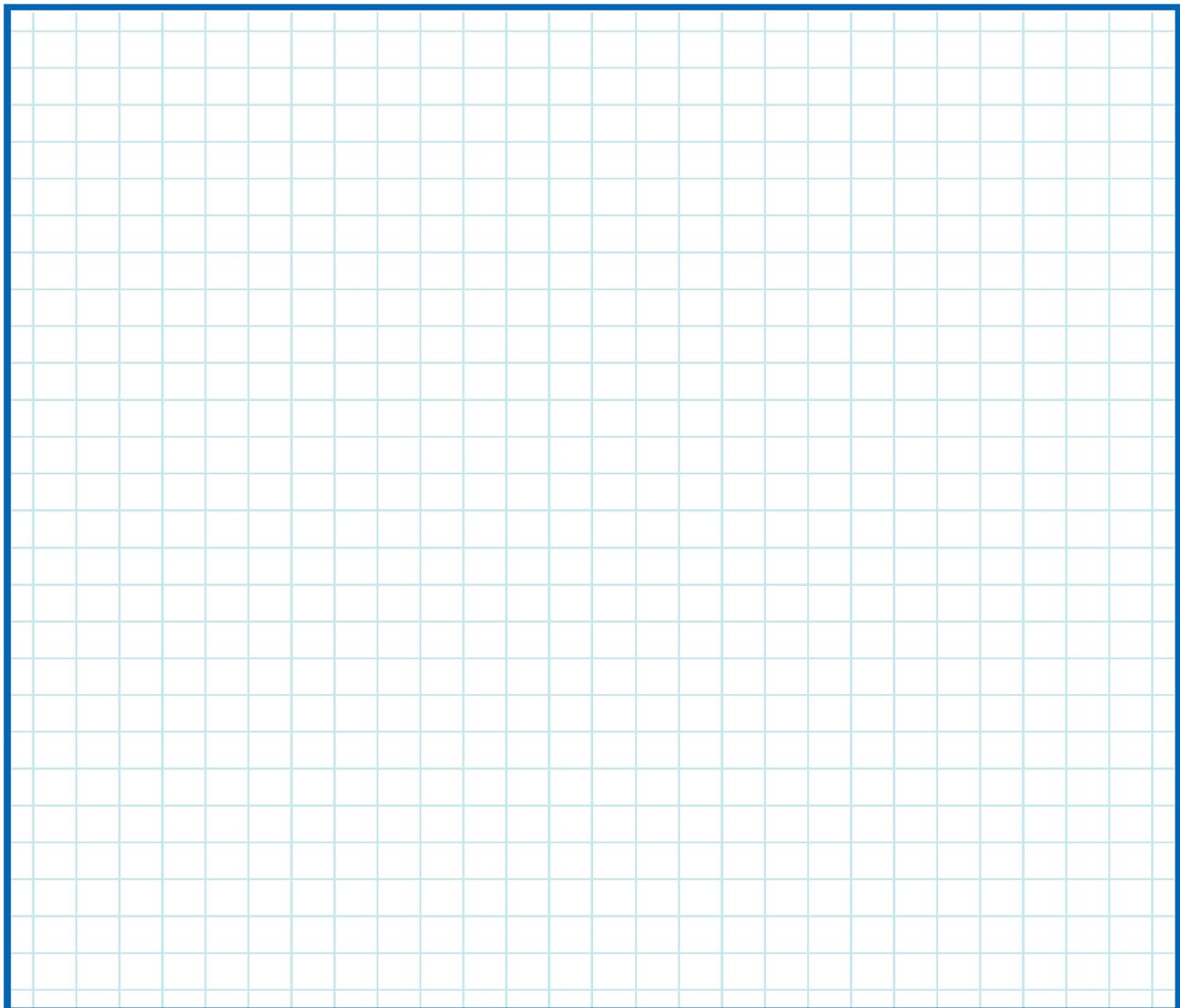


Notes and Drawing Area



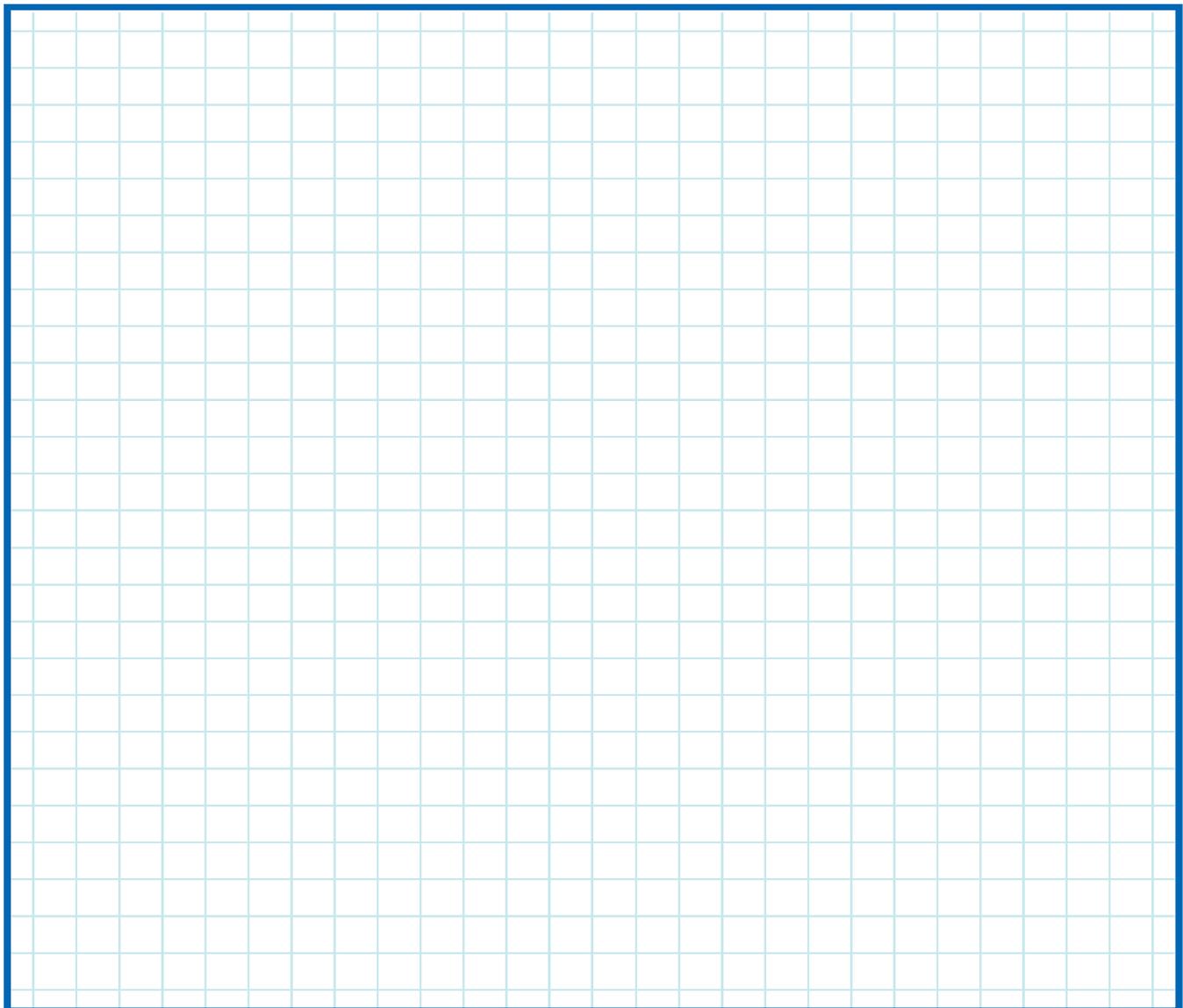


Notes and Drawing Area



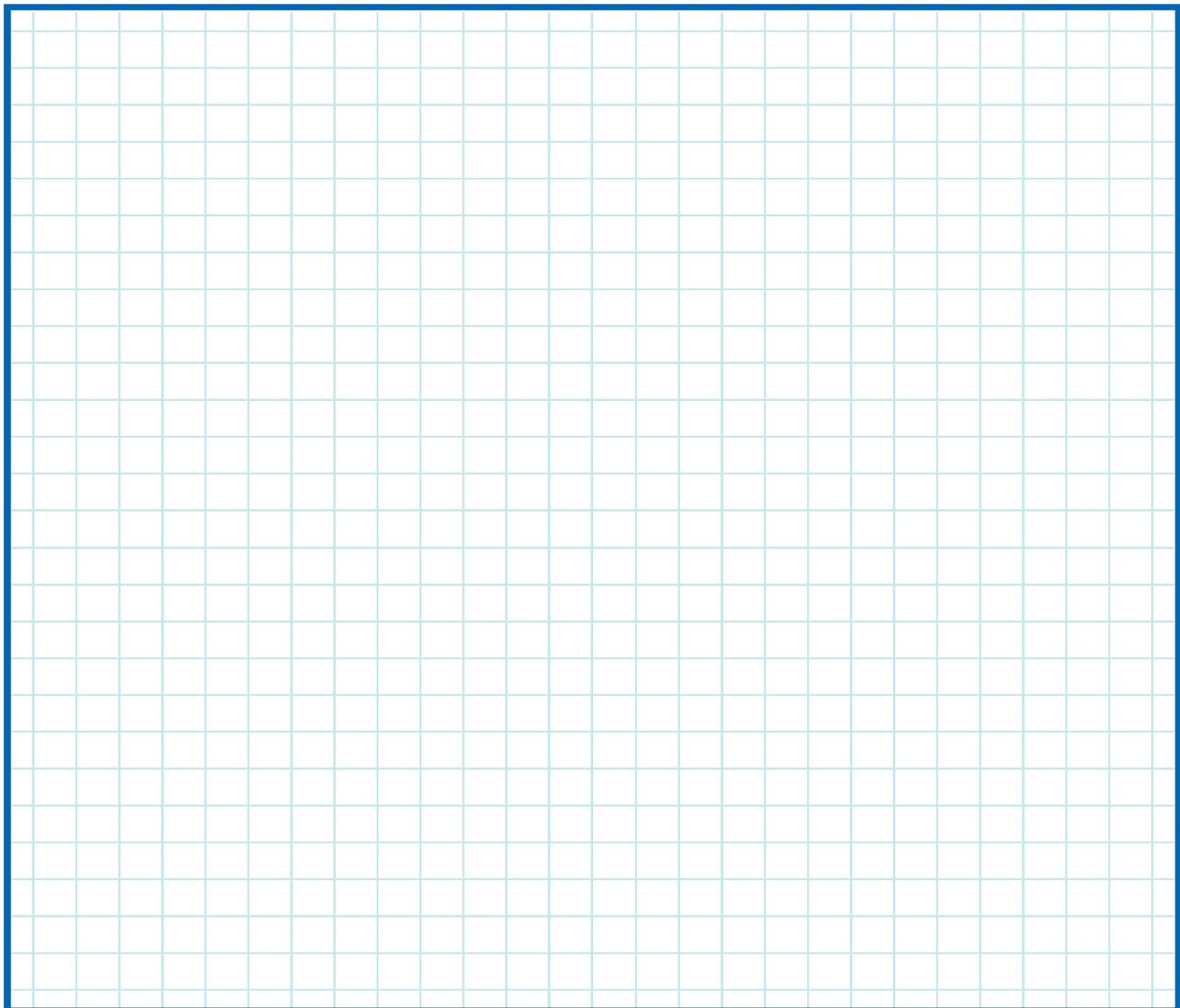


Notes and Drawing Area



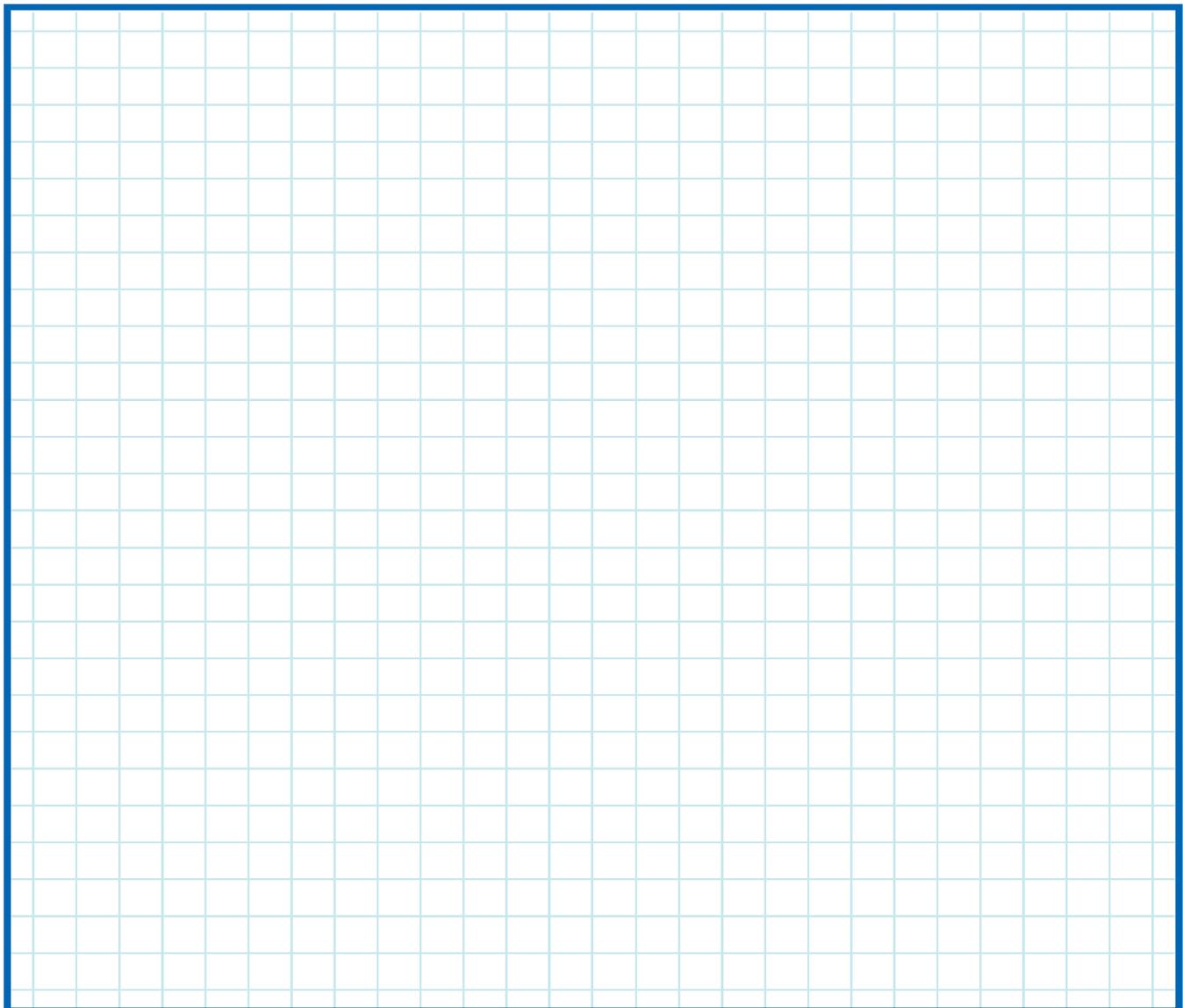


Notes and Drawing Area





Notes and Drawing Area





Notes and Drawing Area

A large rectangular area filled with a light blue grid pattern, intended for drawing or technical sketching.

Name: _____

Team Name: _____

