

Cub Scout Unit Guide for STEM Nova Activities

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INTRODUCTION

STEM stands for science, technology, engineering, and mathematics. STEM has been part of Scouting since its very beginnings—building a fire, identifying plants and animals, orienting a map, and using a compass are all STEM activities. The Nova Awards program was developed to highlight the STEM inherent in the Scouting program and to expose youth to additional STEM opportunities.

STEM activities are fun and exciting for youth, and also activities that are pertinent to our lives and that parents desire for their children. To remain competitive in the world economy, the United States must cultivate the next generation of critical thinkers and innovators. Experts say that our young people need STEM-related skills to compete in the world of tomorrow, where most jobs will require at least a basic understanding of math and science.

Cool experiments, awesome field trips, and fun activities are just part of the full STEM experience for interested Scouts and leaders.

There are different Nova awards for each of the STEM areas. Scouts can earn as many as they would like. Completion of a Nova award earns the Scout the right to wear the Nova award patch. Completion of each additional Nova award is recognized by a pi pin placed on the patch. Each of these awards builds on STEM-related activities, including completing appropriate adventures, participating in hands-on activities, and, often, going on a field trip. As additional Nova awards are developed, their requirements will be posted at www.scouting.org/stem. At the Cub Scout level, it is recommended but not required that Scouts earn one award in each area before earning additional Nova awards.

Award-Based vs. Activity-Based Implementation

Do your Scouts want to earn patches and pins, or do they just want to do fun stuff? Neither approach is “wrong,” and both approaches are discussed in this guide. If you decide on patches and pins, you might want to make a chart for the den or pack with the names of each member and a list of each requirement.

Demonstration vs. Experiment

A demonstration is where you show something cool and then explain what happened. Many times, the Cub Scouts can predict what will happen. An experiment is where you repeat an activity, changing one aspect of it each time, and then measure how the result changes. Sometimes a completely new and unexpected result happens. At the Cub Scout level, it is best to change only one variable at a time to make the analysis of the results straightforward.

NOVA COUNSELORS

Nova counselors are the adults who work directly with Cub Scouts on Nova awards. Nova counselors do not need to be STEM experts or individuals whose careers have been in a STEM field. Much more important are the abilities to work with Cub Scouts and to make the activities fun and challenging at an age-appropriate level. Keep in mind that Cub Scouts range from younger Wolves (second-graders) to older Webelos Scouts (fifth-graders). By reading and learning about a STEM topic, those adults who are able to work with Cub Scouts can be STEM counselors.

You can be a Nova counselor if you are:

- At least 21 years of age
- Of good character
- Able and willing to work with Scout-age youth
- Willing to research STEM topics if you are not familiar or comfortable with them, and willing to partner with a subject matter expert if required
- A registered BSA adult (complete the registration form with position code 58; no fee)
- Current in Youth Protection training

Training can be found at your local council or at www.scouting.org/stem. Some councils have counselors who work with Scouts from any unit or district. Other councils have counselors who work with Scouts in a particular unit. Contact your local council to learn about registering as a counselor.

IMPLEMENTING THE STEM PROGRAM—AWARD BASED

Science Everywhere Nova Award (Science)

In the Science Everywhere Nova Award, Cub Scouts explore how science affects their everyday life. This Nova award is a brief introduction to the scientific method and should include some fun hands-on experiments. Each requirement is spelled out in a format that makes it easy to adopt for a den or a pack meeting. Keep in mind that the ages and experience of the youth may make it difficult to group all Scouts together at a pack meeting. It may make more sense to group Scouts together in dens and have a series of stations.

Your pack meeting program could be the Science Everywhere Nova Award one month. To help your Cub Scouts earn this award within a one-month timeframe, you could add the Nova award requirements to other rank requirements (for part of the meeting).

Week 1:	Requirement 1, 30 minutes
	Requirement 3, 30 minutes (either indoor or outdoor session)
Week 2:	Requirement 4
Week 3:	Appropriate adventure
Week 4:	Requirement 1, 30 minutes
	Requirement 5, 15 minutes

Use a plan that works best for your pack or den, including individual work by Cub Scouts and their families. What works well for one pack or den may not work for another. *The plan included is a suggestion only.*

Tip: Some youth will enjoy the experience if everything is based on a single, simple theme such as rockets, spoilers, or water. Other youth will have a better experience knowing that each activity will focus on a different scientific area. This guide is based on utilizing a different scientific area for each requirement.

Requirement 1

Choose A or B or C and complete ALL the requirements.

A. Watch an episode or episodes (about one hour total) of a show about anything related to science. Then do the following:

- (1) Make a list of at least two questions or ideas from what you watched.
- (2) Discuss two of the questions or ideas with your counselor.

B. Read (about one hour total) about anything related to science. Then do the following:

- (1) Make a list of at least two questions or ideas from what you read.
- (2) Discuss two of the questions or ideas with your counselor.

C. Do a combination of reading and watching (about one hour total) about anything related to science. Then do the following:

- (1) Make a list of at least two questions or ideas from what you read and watched.
- (2) Discuss two of the questions or ideas with your counselor.

The best way to handle this requirement is to break it up into two (approximately 30-minute) sessions. There are a number of excellent science videos or science-related shows that can be recorded and shown to the youth. Most local libraries will have resources that can be borrowed and shown. Be sure to preview the material to be certain it is appropriate for the Scouts. Particularly popular options include:

- “MythBusters” (Discovery Channel, 2003–2016, and Science Channel, 2017–present)
- “The Magic School Bus” (Scholastic; especially good for younger Scouts). This can also be found on Netflix.
- “Raging Planet” (2009; Season 1, Episode 2, “Volcano”; Discovery Channel Series)
- TED Talks (www.TED.com)

Be sure to have a comfortable location where the youth can listen and engage in conversation about the videos. Talk to them about what questions they may have before, during, and after the video. Be certain to engage the youth. In the event the counselor does not have the answer to a Scout’s question (and it can’t be determined from the material), talk about how to research to find the answer.

An additional way to fulfill this requirement is to watch a scientific demonstration. This could be a live demonstration at a local park or science center. The youth will still need to make a list of at least two questions or ideas from the live demonstration and discuss two of those questions with their counselor.

Note that even a time period as short as 30 minutes can be very long for some Cub Scouts. Use care so that the Scout who can watch for hours isn’t disrupted by the Scout with a short attention span and vice versa.

Requirement 2

Complete ONE adventure from the following list for your current rank or complete option A or B. (If you choose an adventure, choose one you have not already earned.) Discuss with your counselor what kind of science, technology, engineering, or math was used in the adventure or option.

Wolf Cub Scouts

Collections and Hobbies
Digging in the Past
Germs Alive!
Grow Something

Bear Cub Scouts

A Bear Goes Fishing
Bear Picnic Basket
Critter Care

Webelos Scouts

Earth Rocks!
Maestro!

Option A: Complete all of the following:

- Explain the scientific method to your counselor.
- Use the scientific method in a simple science project. Explain the results to an adult.
- Talk to a scientist about why he or she became a scientist.

Option B: Complete all of the following:

- Show how to orient a map. Find three landmarks on the map.
- Make a simple compass with a magnet and pin.
- Show how a compass works.
- Use a compass on an orienteering activity with at least three stops.

There is additional information in the Cub Scout den leader guides explaining how to implement the adventures. The guides are available at your local Scout shop or www.scoutstuff.com or electronically through Amazon.com.

Requirement 3

Note to counselor: If Scouts are using the internet as they work on Nova awards, it might be a good idea to offer the opportunity for them to earn their Cyber Chip (www.scouting.org/training/youthprotection/cyberchip.aspx). Earning the Cyber Chip is not, however, a requirement to earn the Nova award.

Act like a scientist! Explore EACH of the following:

- With your counselor, choose a question you would like to investigate. Here are some examples only (you may get other ideas from your adventure activities):
 - Why do rockets have fins? Is there any connection between the feathers on arrows and fins on rockets? Why do some cars have spoilers? How do spoilers work?
 - If there is a creek or stream in your neighborhood, where does it go? Does your stream flow to the Atlantic or the Pacific Ocean?
 - Is the creek or stream in your neighborhood or park polluted?
 - What other activity can you think of that involves some kind of scientific question or investigation?

B. With your counselor, use the scientific method/process to investigate your question. Keep records of your question, the information you found, how you investigated, and what you found out about your question.

C. Discuss your investigation and findings with your counselor.

Within the confines of a meeting, it is best to conduct a hands-on experiment. When possible, allow the Scouts to do the experiment. As the experiment progresses, use the scientific method to discuss the steps.

The scientific method includes:

- Question
- Research
- Hypothesis
- Procedure (including how to measure results)
- Data collection
- Results
- Conclusion/new experiments

Here is an example of an experiment involving soda and Mentos candies:

Supplies needed:	Soda (0.5-liter bottles)
	Mentos (mint flavored)
	Measuring device
	Geyser tubes (or similar device)

- What questions do the youth have based on the items on the supply list? Can they create a question they would like to investigate?
 - What would create the best explosion of soda?
- How would you research the question and decide on a hypothesis?
 - Talking to friends, family, librarians, or science teachers; conducting internet research; watching TED talks or television shows; etc., would be acceptable answers.
- Once the hypothesis is developed, determine how to do the procedure.
 - “I believe the soda with five candies dropped into it will give a bigger explosion than the soda with three candies dropped into it.”
 - Potential procedure:
 - Youth should be wearing safety glasses.
 - Secure two soda bottles side by side so they do not fall over.
 - Place the appropriate number of candies in the geyser tube—three candies in one and five candies in the other.
 - Have youth stand on either side of the geyser tubes and gently pull the string after counting down from 3.
 - Using a visual instrument (your eyes), determine which gave the biggest explosion.
 - If someone has a smartphone, you can record the experiments to play back and make sure of your observations.

- You can also measure the amount of soda remaining in each bottle. The one with the most soda left gave the smallest explosion.
- Collect the data from three iterations (the smallest number of iterations to give valid results).
- Draw conclusions, i.e., “The soda that had five candies dropped into it produced the highest geyser of soda.”
- Determine next experiments:
 - Does the temperature of the soda make a difference?
 - Does the type of soda make a difference?
 - Does the type of candy used make a difference?
- Dispose of all materials properly.

This is a great experiment to do **outside** of the meeting space (i.e., outdoors). Not only does it produce a very visual result, but it also gives the opportunity to include others as they wander by and are curious about what is happening. Diet soda works well for this experiment because it does not attract bugs.

Here is a second example experiment, demonstrating blowing up a balloon using baking soda and vinegar. Note that Scouts will be working in pairs for this experiment.

Supplies needed: Empty soda bottles of similar sizes (two per two youth)

Vinegar

Baking soda

Measuring cups and spoons

Funnels

9-inch round balloons in two colors (three of each color per two youth)

Aluminum foil warming pans—10 x 16 inches and approximately 3 inches deep (one per two youth)

Measuring tape or string

Safety glasses (one pair per youth)

- What questions do the youth have based on the items on the supply list? Can they create a question they would like to investigate?
 - What amount of baking soda would result in the largest balloon if the vinegar amount is kept constant?
- How would you research the question and decide on a hypothesis?
 - Talking to friends, family, librarians, or science teachers; conducting internet research; watching TED talks or television shows; etc., would be acceptable answers.
- Once the hypothesis is developed, determine how to do the procedure.
 - “I believe using 1 tablespoon of baking soda will produce a larger balloon than using 1 teaspoon of baking soda.”
 - Potential procedure:
 - Youth should be wearing safety glasses.

- Separate balloons into different colors. For this example, we used blue and white, but it doesn't matter what the colors are as long as all Scouts use one color for the 1 teaspoon of baking soda and a second color for the 1 tablespoon of baking soda.)
- Place 1 teaspoon of baking soda in the white balloons using the funnel.
- Place 1 tablespoon of baking soda in the blue balloons using the funnel.
- Pour $\frac{1}{2}$ cup of vinegar in each soda bottle and place two soda bottles in each aluminum tray.
- Very gently place a balloon onto the top of each soda bottle without spilling any baking soda.
- At a given time, hold the balloon onto the top of the soda bottle and lift the balloon so the baking soda drops into the vinegar. Continue to hold the balloon onto the bottle until all of the fizzing stops.
- Measure the circumference of each balloon with a measuring tape or string.
- If someone has a smartphone, record the experiments including the measurements. The Cub Scout experimenters can talk about what they are doing and what they observe.
- Repeat two more times.
- Compare the results of the blue balloons vs. the white balloons.
- Collect the data from three iterations (the smallest number of iterations to give valid results).
- Draw conclusions, i.e., "The balloons with 1 tablespoon of baking soda inflated more than those balloons with 1 teaspoon of baking soda."
- Determine next experiments:
 - Does the amount of vinegar make a difference?
 - Does the temperature of the vinegar make a difference?
 - Does the type of vinegar make a difference?
- Dispose of all materials properly.

This is a great experiment to do **inside** of the meeting space. Because everything is contained within the aluminum pan, the "mess" factor of the experiment should be minimized. The second experiment option can be used when the weather is inappropriate for an outdoor experiment or if the meeting space does not lend itself to an outdoor experiment. This could be the "plan B" in case it is needed.

Requirement 4

Visit a place where science is being done, used, or explained, such as one of the following: zoo, aquarium, water treatment plant, observatory, science museum, weather station, fish hatchery, or any other location where science is being done, used, or explained. During your visit, talk to someone in charge about science. Discuss with your counselor the science done, used, or explained at the place you visited.

Tip: If you are following a single theme, be certain to continue it with the visit. For instance, if your theme is fish or water systems, you may wish to visit a fish hatchery or aquarium.

Tip: When visiting another location, it is best to make the arrangements in advance so the facility is fully prepared for the Scouts. This will allow a positive experience for all involved.

If visiting a scientific “place” is not possible, have a scientist visit you. A veterinarian, doctor, nurse, paramedic, firefighter, plumber, or electrician would be great “scientists” to visit the meeting and discuss the kind of “science” they do. Another option would be to poll the adults who are there with their Scouts and find out what kind of STEM they do in their worklife. For example, a baker needs to understand the chemistry of cooking. A firefighter needs to understand the science behind how materials burn and the safest way to put out a fire. Computers and computer science are used in every office. Electrical engineering is used at TV and radio stations.

Requirement 5

Discuss with your counselor how science affects your everyday life.

Another way to discuss Requirement 5 is to ask, “What part of your life has no science?” This can be challenging for the adult who is not comfortable with STEM. However, it is rather difficult to come up with a situation where there is no STEM.

Tip: If you are using a single science theme, such as fish or water systems, you could initiate a discussion about how clean water affects the fish you catch or the food you eat.

1-2-3 Go! Nova Award (Math)

The 1-2-3 Go! Nova Award explores topics in math. The challenge for this award is to include outdoor activities where possible and minimize the number of activities that are sedentary.

Your pack meeting program could be the 1-2-3 Go! Nova Award one month. To help your Cub Scouts earn this award within a one-month timeframe, you could add the Nova award requirements to other rank requirements (for part of the meeting).

- Week 1:** Requirement 1, 30 minutes
- Week 2:** Requirement 2, adventure
- Week 3:** Requirement 3, 30 minutes
 - Requirement 1, 30 minutes
- Week 4:** Requirement 4, 30 minutes
 - Requirement 5, 15 minutes

Requirement 1

Choose A or B or C and complete ALL the requirements.

- A. Watch an episode or episodes (about one hour total) of a show that involves math or physics. Then do the following:
 - (1) Make a list of at least two questions or ideas from what you watched.
 - (2) Discuss two of the questions or ideas with your counselor.
- B. Read (about one hour total) about anything that involves math or physics. Then do the following:
 - (1) Make a list of at least two questions or ideas from what you read.
 - (2) Discuss two of the questions or ideas with your counselor.

C. Do a combination of reading and watching (about one hour total) about anything that involves math or physics. Then do the following:

- (1) Make a list of at least two questions or ideas from what you read and watched.
- (2) Discuss two of the questions or ideas with your counselor.

The best way to handle this requirement is to break it up into two (approximately 30-minute) sessions. There are a number of excellent math videos or math-related shows that can be recorded and shown to the youth. Most local libraries will have resources that can be borrowed and shown. Be sure to preview the material to be certain it is appropriate for the Scouts. Particularly popular options include:

- “The Story of 1” (PBS Home Video)
- “The Great Math Mystery” (PBS Home Video)
- “MythBusters” (Discovery Channel, 2003–2016, and Science Channel, 2017–present)
- “The Magic School Bus” (Scholastic; especially good for younger Scouts).
This can also be found on Netflix.
- TED Talks (www.TED.com)

Be sure to have a comfortable location where the youth can listen and engage in conversation about the videos. Talk to them about what questions they may have before, during, and after the video. Be certain to engage the youth. In the event the counselor does not have the answer to a Scout’s question (and it can’t be determined from the material), talk about how to research to find the answer.

An additional way to fulfill this requirement is to watch a scientific demonstration that deals specifically with math or numbers. This could be a live demonstration at a local park or science center. The youth will still need to make a list of at least two questions or ideas from the live demonstration and discuss two of those questions with their counselor.

Note that even a time period as short as 30 minutes can be very long for some Cub Scouts. Use care so that the Scout who can watch for hours isn’t disrupted by the Scout with a short attention span and vice versa.

Requirement 2

Complete ONE adventure from the following list for your current rank or complete option A or B. (If you choose an adventure, choose one you have not already earned.) Discuss with your counselor what kind of science, technology, engineering, or math was used in the adventure or option.

Wolf Cub Scouts

Code of the Wolf

Bear Cub Scouts

Robotics

Webelos Scouts

Game Design

Option A: Complete both of the following: (a) Conduct an opinion survey through which you collect data to answer a question and then show your results with a chart or graph. For example, what is the favorite food of the Scouts in your den? (Chart how many like pizza, how many like cookies, etc.) (b) Conduct and keep a record of a coin toss probability experiment. Keep track of at least 25 tosses.

Option B: Complete both of the following: (a) Interview four adults in different occupations and see how they use measurement in their job. (b) Measure how tall someone is. Have him or her measure you. Take the measurements in both inches and centimeters.

There is additional information in the Cub Scout den leader guides explaining how to implement the adventures. The guides are available at your local Scout shop or www.scoutstuff.com or electronically through Amazon.com.

Requirement 3

Note to counselor: If Scouts are using the internet as they work on Nova awards, it might be a good idea to offer the opportunity for them to earn their Cyber Chip (www.scouting.org/training/youthprotection/cyberchip.aspx). Earning the Cyber Chip is not, however, a requirement to earn the Nova award.

Explore TWO options from A or B or C and complete ALL the requirements for those options. Keep your work to share with your counselor. The necessary information to make your calculations can be found in a book or on the internet. You may work with your counselor on these calculations.

A. Choose TWO of the following places and calculate how much you would weigh there.

- (1) On the sun or the moon
- (2) On Jupiter or Pluto
- (3) On a planet that you choose

B. Choose ONE of the following and calculate its height:

- (1) A tree
- (2) Your house
- (3) A building of your choice

C. Calculate the volume of air in your bedroom. Make sure your measurements have the same units—all feet or all inches—and show your work.

Utilize the counselor section in the *Cub Scout Nova Awards Guidebook* to help your Cub Scouts complete these requirements. For item 3C, you could substitute another room for a bedroom. If you are meeting in a school, a gymnasium made of cinder blocks could be a particularly interesting activity for the Scouts. As an added possibility (not a requirement), the Scouts could measure the volume of two rooms that are shaped differently (long and narrow vs. wide) to see how similar the volumes can be.

Requirement 4

Secret Codes

A. Look up, then discuss with your counselor each of the following:

- (1) Cryptography
- (2) At least three ways secret codes or ciphers are made
- (3) How secret codes and ciphers relate to mathematics

B. Design a secret code or cipher. Then do the following:

- (1) Write a message in your code or cipher.
- (2) Share your code or cipher with your counselor.

Utilize the counselor section in the *Cub Scout Nova Awards Guidebook* to help your Cub Scouts complete these requirements. Make sure the activity is age appropriate. For example, a simple substitution cipher, or Caesar cipher, may be enough for younger Scouts, while a more complicated cipher such as a one-time pad might be more interesting for Webelos Scouts or more mathematically inclined Scouts.

Requirement 5

Discuss with your counselor how math affects your everyday life.

This discussion can be a simple conversation about math in a student's everyday life:

- How do I use the clock to know when to go to school?
- How much money does it take to buy breakfast or lunch?
- How many minutes are in recess?
- How many jumping jacks do I need to do in physical education class?
- How many steps are there from my classroom to the library?
- What is the distance (in steps or miles) from my school to my home?
- How many students wore blue shirts today?
- How many students wore red shirts today?
- How much time do I need to spend reading my book for homework?
- In what places is math not needed?

Receiving the Nova Award

1. Completion of the Nova award must be approved by a registered BSA Nova counselor.
2. Nova awards are reported on a standard Advancement Report, No. 34403.
 - (a) Turn in the report at the local Scout shop in order to purchase the Nova emblem (first Nova award earned) and pi pins (second and all subsequent Nova awards earned).
 - (b) The report must indicate which Nova award was earned by which Scout.

IMPLEMENTING THE STEM PROGRAM—ACTIVITY BASED

STEM is prevalent in everyday Cub Scouting as well as in the activities required to earn adventures. There is science involved when taking a hike. (Which plants are safe to touch? How do I identify this animal footprint? Are there other animal signs? Is it going to rain or snow today?) Technology can be found in learning how to read a map or measure the depth of a stream with a hiking staff. Engineering can be found in the levers of a playground, and math is everywhere. (How deep is the creek and how can I safely measure it without getting wet?)

Highlighting STEM activities built into rank advancement and other awards is an easy way to include STEM while doing the “normal” business of the Cub Scout pack.

A STEM-based den or pack meeting can be a wonderful way to attract new Scouts and families (having a raingutter regatta or using wrist rockets). It can keep youth involved in Cub Scouts longer. Conducting hands-on science experiments can re-engage Scouting families that traditionally are very scarce after the blue and gold banquet or after rank advancement is complete.

Explaining the STEM behind pinewood derby cars (drag, friction, body design) can help to make your pinewood derby less of a competition between the adults and more of a fun learning experience for the youth. For example, setting up an extra track and testing the placement of extra weights in the car can be a fabulous learning experience and a great hands-on activity early in the car design process.

Observing signs of wildlife, following a trail (how it is marked), discussing the natural environment, identifying trees and plants, monitoring weather, and similar activities can be a normal part of the STEM experience within the pack. Hiking equipment and attire can spark a very interesting conversation, depending on the local environment. Doing a simple experiment with a wicking shirt vs. a cotton shirt can be a fabulous STEM moment that is not tied to an award or recognition.

STEM teaching moments should come as a part of normal conversation and should not be a “lecture.” There is a significant value to asking leading questions to help Scouts explore the STEM topic at hand.

You can develop monthly programs for other Nova award topics if you wish based on the outlines and schedules here. The STEM program and the Nova awards are optional, supplemental parts of the Cub Scouting program. However, many Cub Scouts love the STEM and Nova award activities, and those who don’t love them will at least have tried them.

ON TO SUPERNOVA

Once the pack or den has conquered a couple of Nova awards, it may be time to move on to a Supernova award. Note, however, that youth are not required to earn Nova awards before earning a Supernova award. Supernova awards are earned on an individual basis or within a group where a Scout completes a more in-depth science exploration under the direction of an approved Supernova mentor. (Please contact your local council about finding a mentor.)

To earn the Supernova awards within a group setting, one option is to conduct Supernova activities immediately preceding the regular Scouting meeting. Scouts who are interested in earning Supernova awards can arrive to the meeting 30 minutes early and work with the Supernova mentor on a requirement or two. (Keep Youth Protection guidelines in mind.) These meetings can be spread out to a schedule that works well for all involved. If these extra meetings are once a month, the Supernova could be earned within a single Scouting year.

By adding a “Supernova session” onto the regular meeting, you eliminate the need for extra meetings and extra meeting space for this award. Those Scouts who are interested can participate; those Scouts who are not interested simply arrive at the normally scheduled time.

For more information, see the *Cub Scout Nova Awards Guidebook*.



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