

## Reasoning, Hypothesis, Experimentation

Some kids know that one of the best ways to irritate their parents is to ask a bunch of questions: What is air? How does electricity work? Why do balls bounce? Why can't I fly? Why can't dogs talk? How does gravity work? Why is snow white when water isn't? What is lightning? What is thunder?

Scientists are a lot like those little kids. They are curious, and they ask hard questions that have been perplexing people for years. But then they do something else: They find answers. They develop hypotheses (possible answers) and then set out to prove those hypotheses through observation and experimentation. Their answers might just add to humanity's knowledge base, but on occasion, their answers lead to breakthroughs in medicine, technology, space travel, and many other fields.

This month, Scouts will get a taste of what it's like to be a scientist. The unit's weekly meetings will be full of engaging experiments, while the main event will take the unit out into the world of science. Who knows? Some Scouts may even decide that asking—and answering—questions is something they want to do for the rest of their life.

### Objectives

This month's activities should:

- Define what science is
- Help Scouts understand careers that use science
- Help Scouts understand and demonstrate the scientific method
- Help Scouts understand the different sciences, or "-ologies"
- Relate science to science fiction
- Encourage Scouts to earn the Nova and Supernova awards

### RELATED ADVANCEMENT AND AWARDS

- Merit badges: Animal Science, Archaeology, Astronomy, Chemistry, Composite Materials, Digital Technology, Electricity, Energy, Engineering, Environmental Science, Geology, Insect Study, Mammal Study, Medicine, Nature, Nuclear Science, Oceanography, Plant Science, Programming, Reptile and Amphibian Study, Robotics, Soil and Water Conservation, Space Exploration, Sustainability, Veterinary Medicine, Weather
- Nova and Supernova awards



## LEADERSHIP PLANNING

As a leadership team, you may want to discuss the following items when choosing science as your program feature during your planning meetings.

1. Choose a main event.
2. Is there a science museum nearby?
3. Is there a science fair in the near future?
4. What are the travel demands for the main event?
5. Will the main event be an overnigher?
6. What science fiction movie/show will we watch?
7. Who will present the instruction portions?
8. Where will we do our main event?
9. How can we involve parents?
10. What science-related merit badge should we focus on?
11. To meet our needs, what should we change in the sample meeting plans?

### Parents can help with the Science program feature by:

1. Sharing their expertise
2. Providing transportation for the main event
3. Providing materials for the chemistry, biology, and physics experiments
4. Supplying catapult materials (such as Tinkertoys®)
5. Maintaining current Youth Protection certification, which is required of all adults providing transportation for or participating in camping outings

## THREE AREAS OF SCIENCE

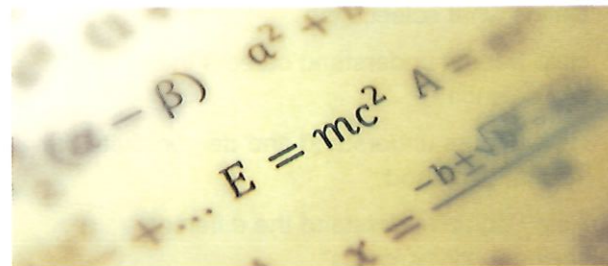
Science is the study of the structure and behavior of the physical and natural world through observation and experimentation. Because science studies literally everything, scientists specialize in many areas. Although some specialties overlap, all sciences tend to focus on one area of the chemical, living, or physical world.



**Chemistry** deals with the identification of the substances of which matter is composed, the investigation of their properties, and the ways in which they interact, combine, and change.



**Biology** is the study of living organisms, divided into many specialized fields that cover their morphology (form and structure), anatomy (the branch of morphology that deals with structure), physiology (function and activities), behavior, origin, and distribution.



**Physics** is the scientific study of matter and energy and how they interact with each other. Physics often explains the fundamental mechanisms of other sciences.



## SCIENCE GAMES

### Match the “-ology”

**Equipment:** 5-by-7 cards with one word on each to make science pairs: geology/rocks, biology/living things, cardiology/heart, zoology/animals, etc. (See “Scientific Specialties” below for ideas.)

**How to play:** Shuffle the cards; have each player take one without looking at it. When told to begin, each player tries to find the person with the corresponding card. Points can be awarded individually or by teams; 1 point per correct match.

### Sci-fi Trivia

**Equipment:** A list of sci-fi trivia questions and answers. Find questions and answers through an internet search or create your own.

**How to play:** Two options—teams take turns answering questions OR players write the answers on their own sheet of paper. The winner is the team or player with the most correct answers.

**Variations:** 1. Create a “Jeopardy!”-style game with multiple categories and escalating point values; 2. Let teams create and ask their own trivia questions, and award points when they stump the other teams.

### Human Knot

**Equipment:** None

**How to play:** The group stands shoulder to shoulder in a circle. Players reach into the middle with both hands and grab two other hands at random, making sure they don’t belong to the same person. Without letting go, the group

untangles the “knot.” Afterward, discuss what hypothesis, theories, and facts players used to get untangled.

### Blind Cannon

**Equipment:** Blindfolds and large, heavy sponges (dampen them to give them more weight)

**How to play:** Two teams face each other across “no man’s land,” about 15 feet apart. (Determine a distance based on how far a sponge can be thrown.) Each team has one general and one or two “cannons”—blindfolded players who throw sponges. The generals stand still on their respective sides of the playing field and give direction to their cannons. The cannons try to strike the opposing generals with their sponges. Other players collect sponges and return them to the cannons. The last general standing wins.

### Marshmallow Catapult Contest

**Equipment:** Materials to make a catapult, a bucket for a target, and marshmallows as ammo. Tinkertoys work well for catapults, but with a little imagination other materials can be used.

**How to play:** Each player or team creates a catapult that can shoot marshmallows at a bucket placed across the room. The person or team to get the most marshmallows in the bucket wins.



## SCIENTIFIC SPECIALTIES

The suffix “-ology” means “the study of.” Words formed with this suffix describe the study of a particular subject. The areas of scientific studies are almost endless. Here are a few of the “ologies” and other scientific specialties.

**Anthropology**—the study of humans

**Archeology**—study of prehistoric peoples and cultures

**Astronomy**—the study of celestial bodies

**Biology**—the study of life

**Cardiology**—the study of the heart

**Dermatology**—the study of skin

**Entomology**—the study of insects

**Ethnology**—the study of cultures

**Geology**—the study of rocks and minerals

**Hematology**—the study of blood

**Hydrology**—the study of water

**Ichthyology**—the study of fish

**Microbiology**—the study of microscopic organisms

**Oncology**—the study of cancer

**Neurology**—the study of the nervous system

**Paleontology**—the study of fossils

**Psychology**—the study of the human mind

**Radiology**—the study of X-rays and their medical application

**Seismology**—the study of earthquakes

**Toxicology**—the study of toxins

**Volcanology**—the study of volcanoes

**Zoology**—the study of animals



# E.D.G.E. Ideas

*Explain* how it is done—Tell them.

*Demonstrate* the steps—Show them.

*Guide* learners as they practice—Watch them do it.

*Enable* them to succeed on their own—Have them practice/teach it.

## EXPLAIN

- Define science.
- Discuss the three main areas of science.
- Define “-ology” and give examples.
- Discuss the scientific method and the difference between a hypothesis, a theory, and a law.
- Show a science video from the internet that discusses a scientific principle.

## DEMONSTRATE

- Conduct a live chemistry, biology, or physics experiment.
- Show a YouTube or other internet video of a science experiment.
- Show why certain science fiction “facts” are impossible or implausible.
- Demonstrate a simple catapult.
- Show a sample science fair project.

## GUIDE

- Have Scouts conduct a simple science experiment while you supervise.
- Lead a reflection on an experiment the Scouts have conducted.
- Watch as Scouts design and built catapults, offering guidance throughout the process.
- Have Scouts work through a step in developing a science fair project.
- Help Scouts identify scientists or groups the unit could work with for the main event.

## ENABLE

- Challenge Scouts to develop science fair projects.
- Have Scouts watch a science fiction show and critique the false science principles it embraces.
- Encourage Scouts to pursue a Nova or Supernova award.
- Have older Scouts lead younger Scouts in science experiments.
- Have Scouts teach a Cub Scout belt loop like Astronomy or Science.

## MAIN EVENT SUMMARIES

● ESSENTIAL	■ CHALLENGING	◆ ADVANCED
Day Activity	Day Activity	Overnight Activity
Science museum visit—Visit a science museum or aviation museum. Arrange ahead of time to talk with a docent or staff member about a science topic related to the museum's exhibits.	Science fair—Create tabletop displays that highlight a scientific topic and present it at a local science fair. Decide what prizes you would give if you were in charge. If you can't find a local science fair, hold your own within your unit.	Research project—Contact a local college or environmental agency and volunteer to assist in a research project. Possibilities include participating in a fish count or bird count, identifying trees, or assisting in a geological or archeological dig.



# SCIENCE

## Meeting Plan: What Is Science?



Week 1 Date \_\_\_\_\_

ACTIVITY	DESCRIPTION	RUN BY	TIME*
<b>Preopening</b> 15 minutes before meeting	Show short science videos as Scouts arrive.		6:45 p.m.
<b>Opening Ceremony</b> 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
<b>Group Instruction</b> 5 minutes	Discuss the following: <ul style="list-style-type: none"> <li>• The definition of science</li> <li>• The suffix “-ology” and some specific “ologies”</li> <li>• The three main branches of science: chemistry, biology, physics</li> </ul>		7:10 p.m.
<b>Skills Instruction</b> 45 minutes	Conduct these experiments and discuss the scientific principles involved.		7:15 p.m.
	Chemistry: Combine baking soda and vinegar. Biology: Grow bean sprouts. Physics: Use levers and pulleys to move weights.		
	Chemistry: Combine Mentos and diet soda. Biology: Chart each Scout's height and shoe size and look for correlations. Physics: Ricochet marbles off one another.		
	Chemistry: Make a battery. Biology: Breed fruit flies and discuss genetics. Physics: Create a dominoes chain reaction and measure how long it takes dominoes in different configurations to fall		
<b>Breakout Groups</b> 15 minutes	<ul style="list-style-type: none"> <li>• New members practice basic Scout skills.</li> <li>• Older members choose a science-related merit badge or Nova award to work on together.</li> <li>• Review the last main event and discuss what could have made it better.</li> </ul>		8 p.m.
<b>Game</b> 10 minutes	Play Match the “-ology” (described earlier).		8:15 p.m.
<b>Closing</b> 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
<b>Total 90 minutes of meeting</b>			
<b>After the Meeting</b> 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

\*All times are suggested.



# SCIENCE

## Meeting Plan: Potential Energy



Week 2 Date \_\_\_\_\_

ACTIVITY	DESCRIPTION	RUN BY	TIME*
<b>Preopening</b> 15 minutes before meeting	Play Blind Cannon (described earlier).		6:45 p.m.
<b>Opening Ceremony</b> 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
<b>Group Instruction</b> 20 minutes	<ul style="list-style-type: none"> <li>• Teach the basics of projectile motion.</li> <li>• Explain how angle and force combine to launch projectiles.</li> <li>• Define projectile and projectile motion.</li> <li>• Discuss the difference between forward velocity and acceleration due to gravity.</li> </ul>		7:10 p.m.
<b>Skills Instruction</b> 20 minutes	<ul style="list-style-type: none"> <li>• On paper, design a basic catapult.</li> </ul>		7:30 p.m.
	<ul style="list-style-type: none"> <li>• Build the catapult you designed using material like Tinkertoys.</li> <li>• Practice loading and firing the catapult.</li> <li>• Keep a record of distance.</li> </ul>		
	<ul style="list-style-type: none"> <li>• On paper, design a catapult with adjustable elevation and force.</li> <li>• Using household items, build the catapult you designed.</li> <li>• Practice loading and firing the catapult.</li> <li>• Keep a record of angle, force, and distance.</li> </ul>		
<b>Breakout Groups</b> 15 minutes	<ul style="list-style-type: none"> <li>• On paper, design a catapult with adjustable elevation and force.</li> <li>• Build the catapult you designed using dowels and lashings of string.</li> <li>• Practice loading and firing the catapult.</li> <li>• Keep a record of angle, force, and distance.</li> </ul>		
	<ul style="list-style-type: none"> <li>• New members practice basic Scout skills.</li> <li>• Older members choose a science-related merit badge or Nova award to work on together.</li> <li>• Make plans for participation in main event.</li> </ul>		7:50 p.m.
<b>Game</b> 20 minutes	Play Marshmallow Catapult Contest (described earlier).		8:05 p.m.
<b>Closing</b> 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
<b>Total 90 minutes of meeting</b>			
<b>After the Meeting</b> 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

\*All times are suggested.



# SCIENCE

## Meeting Plan: Scientific Method



Week 3 Date \_\_\_\_\_

ACTIVITY	DESCRIPTION	RUN BY	TIME*
<b>Preopening</b> 15 minutes before meeting	Play Three-Person Tug-of-War (see <i>Troop Program Resources</i> ).		6:45 p.m.
<b>Opening Ceremony</b> 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
<b>Group Instruction</b> 20 minutes	<ul style="list-style-type: none"> <li>Define the scientific method.</li> <li>Explain the difference between hypotheses, theories, and laws.</li> <li>Compare and contrast experimentation and observation.</li> </ul>		7:10 p.m.
<b>Skills Instruction</b> 30 minutes	<ul style="list-style-type: none"> <li>Design an inhabited base located on the moon or Mars.</li> </ul>		7:30 p.m.
	<ul style="list-style-type: none"> <li>Discuss what theories and laws you need to consider.</li> <li>Discuss sources of energy, construction process, life support, and purpose.</li> <li>Draw or make a model of your base.</li> </ul>		
	<ul style="list-style-type: none"> <li>Make a theory of how gravity works.</li> <li>Discuss what scientific laws are involved in your theory.</li> <li>Devise experiments that could test your theory.</li> <li>Repeat this process for other topics.</li> </ul>		
	<ul style="list-style-type: none"> <li>Research a modern scientific subject.</li> <li>Find two competing theories and defend one of them in a debate. (This could be done in an ethical controversy format.)</li> </ul>		
<b>Breakout Groups</b> 15 minutes	<ul style="list-style-type: none"> <li>New members practice basic Scout skills.</li> <li>Older members choose a science-related merit badge or Nova award to work on together.</li> <li>Make plans for participation in main event.</li> </ul>		8 p.m.
<b>Game</b> 10 minutes	Play Human Knot (described earlier).		8:15 p.m.
<b>Closing</b> 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
<b>Total 90 minutes of meeting</b>			
<b>After the Meeting</b> 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

\*All times are suggested.



# SCIENCE

## Meeting Plan: Science vs. Science Fiction



Week 4 Date \_\_\_\_\_

ACTIVITY	DESCRIPTION	RUN BY	TIME*
<b>Preopening</b> 15 minutes before meeting	Play Science Fiction Charades: Take turns acting out scenes from sci-fi movies or portraying familiar sci-fi characters.		6:45 p.m.
<b>Opening Ceremony</b> 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
<b>Group Instruction</b> 30 minutes	<ul style="list-style-type: none"> <li>Discuss how science fiction is often rooted in science fact.</li> <li>Watch an episode of a sci-fi series like "Star Trek," "Doctor Who," "Stargate," or "Battlestar Galactica" (or part of a sci-fi movie).</li> </ul>		7:10 p.m.
<b>Skills Instruction</b> 30 minutes	<ul style="list-style-type: none"> <li>Give examples of science fact in the show you just watched.</li> </ul>		7:40 p.m.
	<ul style="list-style-type: none"> <li>Give examples of science fiction in the show you just watched.</li> <li>What advances in science would be required to make the examples of science fiction into science fact?</li> </ul>		
	<ul style="list-style-type: none"> <li>What scientific laws were used in the show you just watched?</li> <li>Name something that was impossible.</li> <li>Identify two examples of technological or scientific advances in the chosen show and discuss how they could come to pass.</li> </ul>		
	After watching the show, explain what was possible and impossible in the show. Share with the group what you learned. If you were a scientific consultant on this show, tell what changes you would suggest to make it more scientifically accurate.		
<b>Breakout Groups</b> 15 minutes	<ul style="list-style-type: none"> <li>New members practice basic Scout skills.</li> <li>Older members choose a science-related merit badge or Nova award to work on together.</li> <li>Confirm assignments for main event.</li> </ul>		8 p.m.
<b>Game</b> 10 minutes	Play Sci-Fi Trivia (described earlier).		8:15 p.m.
<b>Closing</b> 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
<b>Total 90 minutes of meeting</b>			
<b>After the Meeting</b> 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

\*All times are suggested.





# SCIENCE

## Main Event: Science Museum Visit



Date \_\_\_\_\_

**Logistics**

Location: \_\_\_\_\_  
 \_\_\_\_\_

Departure time: \_\_\_\_\_

Return time: \_\_\_\_\_

Duration of activity: 4 hours

Budget: Completed \_\_\_\_\_ Approved \_\_\_\_\_

Camping: Duty roster \_\_\_\_\_ Menu \_\_\_\_\_

Transportation: Group \_\_\_\_\_ Self \_\_\_\_\_

Tour and activity plan: Completed \_\_\_\_\_ Submitted \_\_\_\_\_

**Essential (Tier I)**

Visit a science museum or aviation museum. Arrange ahead of time to talk with a docent or staff member about a science topic related to the museum's exhibits.

**Equipment List**

- Decided-upon uniform
- Pad and paper for taking notes
- Camera
- Lunch (decide on individual or group)
- Cellphones as appropriate
- Water
- Scout Basic Essentials (Review the list and take what you need.)

**Activity**

- Choose a science or aviation museum near you.
- Research the hours of operation and cost.
- Contact the museum to arrange to talk to a docent.
- Explore the museum.
- Select one exhibit that interests you and learn all you can about it.
- After the group reassembles at a designated time, report to the others on what you learned.

**Safety**

Use the buddy system. Have a first-aid kit. Cellphones are a good idea.

**Notes**



# SCIENCE

## Main Event: Science Fair



Date \_\_\_\_\_

### Logistics

Location: \_\_\_\_\_

Departure time: \_\_\_\_\_

Return time: \_\_\_\_\_

Duration of activity: 4 to 8 hours

Budget: Completed \_\_\_\_\_ Approved \_\_\_\_\_

Camping: Duty roster \_\_\_\_\_ Menu \_\_\_\_\_

Transportation: Group \_\_\_\_\_ Self \_\_\_\_\_

Tour and activity plan: Completed \_\_\_\_\_ Submitted \_\_\_\_\_

### Challenging (Tier II)

Create tabletop displays that highlight a scientific topic and present it at a local science fair. Decide what prizes you would give if you were in charge. If you can't find a local science fair, hold your own within your unit.

### Equipment List

- Your science fair entry
- Decided-upon uniform
- Pad and paper for taking notes
- Camera
- Lunch (decide on individual or group)
- Cellphones as appropriate
- Water
- Scout Basic Essentials (Review the list and take what you need.)

### Activity

- Find a science fair or contest in your area.
- Determine the entry requirements.
- Enter your group/individual project.
- Set up and present your topic at the science fair.
- Explore the other exhibits.
- Decide who you would give awards to.
- Participate in the awards ceremony.
- After the group reassembles at the designated time, report to the others on what interested you the most.

### Safety

Use the buddy system. Have a first-aid kit. Cellphones are a good idea.

### Notes



# SCIENCE

## Main Event: Research Project



Date \_\_\_\_\_

### Logistics

Location: \_\_\_\_\_

Departure time: \_\_\_\_\_

Return time: \_\_\_\_\_

Duration of activity: Weekend

Budget: Completed \_\_\_\_\_ Approved \_\_\_\_\_

Camping: Duty roster \_\_\_\_\_ Menu \_\_\_\_\_

Transportation: Group \_\_\_\_\_ Self \_\_\_\_\_

Tour and activity plan: Completed \_\_\_\_\_ Submitted \_\_\_\_\_



### Advanced (Tier III)

Contact a local college or environmental agency and volunteer to assist in a research project. Possibilities include participating in a fish count or bird count, identifying trees, or assisting in a geological or archeological dig.

### Equipment List

- Appropriate clothing
- Equipment needed for research
- Cellphones or two-way radios as appropriate
- Computers, if needed
- Power source, if needed
- Camping gear as needed
- First-aid kit
- Meal plan
- Water
- Scout Basic Essentials (Review the list and take what you need.)

### Activity

- Decide on an area of interest for the research project.
- Contact colleges, universities, or environmental agencies for research opportunities.
- Invite a researcher to visit with group.
- Determine how your group will assist with the research.
- Make appropriate assignments.
- Consider safety needs.
- Make plans to camp near the research site.
- Work on research project as planned.
- Submit research results and/or observations.
- Follow up to find out when the research is published.

### Safety

Identify possible risks of research activity. Have a first-aid kit and develop a plan in case a researcher needs medical assistance. Consider using two-way radios.

### Notes



## RESOURCES AND REFERENCES

### Books

*Animal Science, Archaeology, Astronomy, Chemistry, Composite Materials, Digital Technology, Electricity, Energy, Engineering, Environmental Science, Geology, Insect Study, Medicine, Nuclear Science, Oceanography, Plant Science, Programming, Reptile and Amphibian Study, Robotics, Soil and Water Conservation, Space Exploration, Sustainability, Veterinary Medicine, and Weather* merit badge pamphlets

Nova Awards pamphlets

### Organizations and Websites

#### Chem4Kids.com

Website: <http://chem4kids.com>

#### Science journal

Website: <http://www.sciencemag.org>

#### ItsNotMagicItsScience.com

Website: <http://www.itsnotmagicitsscience.com>

#### Science Friday

Website: <http://www.sciencefriday.com>

### Related Program Features

Engineering, Mathematics, Technology

### Photo and Illustration Credits

Pages 14-1 (Shutterstock.com, courtesy: ©Andrii Muzyka), 14-2 (Shutterstock.com, courtesy: *periodic table of elements*, ©isak55; *DNA*, ©graphiks; *formula of relativity*, ©Fernando Batista), and 14-3 (Shutterstock.com, courtesy: ©Dani Simmonds)

### Acknowledgments

We appreciate and are very grateful to Jim Virgin, Vancouver, Washington, for developing the Science program feature.