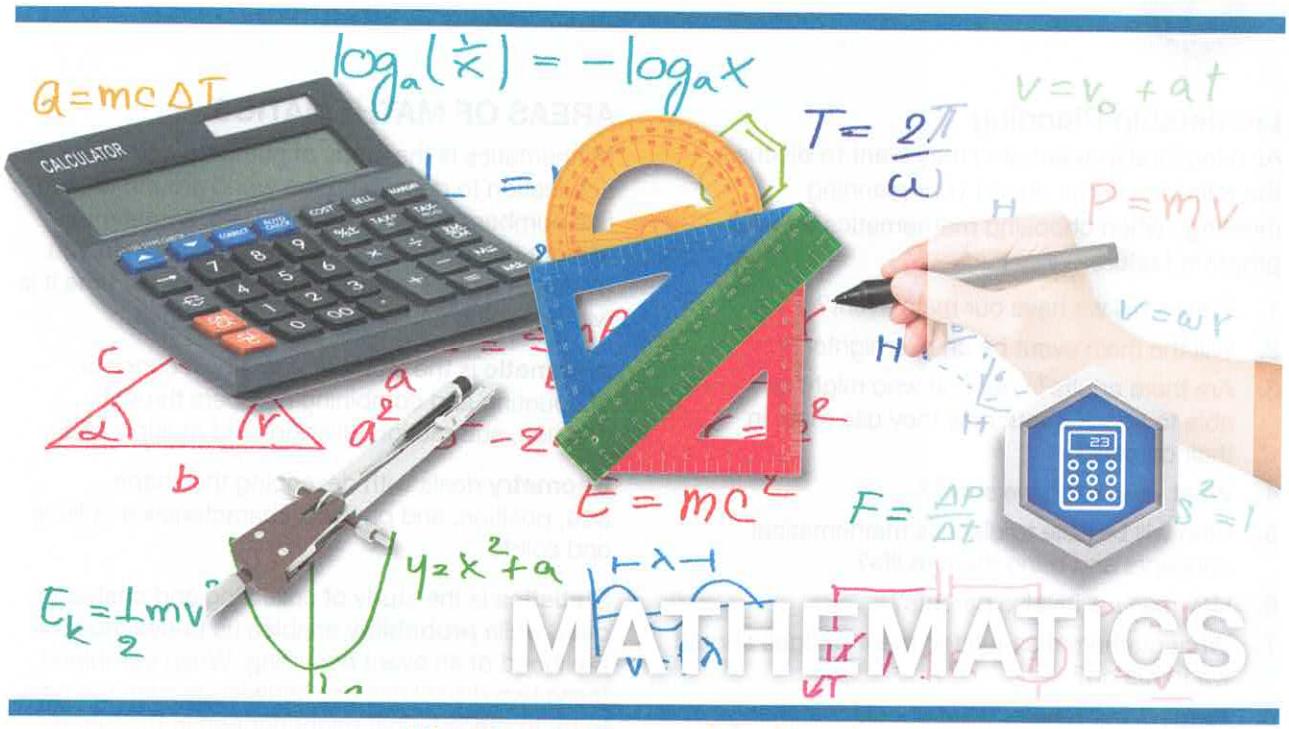


Numbers, Formulas, Logic

You might think mathematics is just a class you have to take in school, but it is actually an important part of our everyday lives. Even though you may not notice it at first, its applications are widespread. From calculating the amount of money you have to pay when shopping to ensuring the safety of the bridges you use, mathematics has many different applications.

This month, you will have the opportunity to learn about how mathematics affects our everyday lives. The unit's weekly meetings will be full of activities that make mathematical concepts fun to learn and apply.

Objectives

This month's activities should:

- Define what mathematics is.
- Demonstrate how mathematics is used in everyday life.
- Encourage Scouts to earn the Nova and Supernova awards.
- Increase understanding of and demonstrate different mathematical concepts.
- Explore the different areas of study within mathematics.
- Expose Scouts to careers that use mathematics.

RELATED ADVANCEMENT AND AWARDS

- Architecture, Aviation, Chess, Cooking, Digital Technology, Drafting, Electronics, Energy, Engineering, Entrepreneurship, Game Design, Home Repairs, Metalwork, Model Design and Building, Nuclear Science, Orienteering, Personal Management, Pioneering, Programming, Robotics, Salesmanship, Surveying, Welding, and Woodwork merit badges
- Nova and Supernova awards

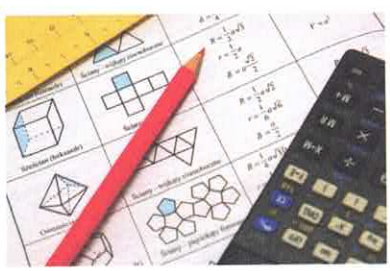
Leadership Planning

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

1. Where will we have our main event?
2. Will the main event be an overnighter?
3. Are there adults in our unit who might be able to speak about how they use math in their careers?
4. What videos will we show?
5. Who will be able to discuss mathematical concepts and bring them to life?
6. How can we involve parents?
7. What mathematics-related merit badges should we focus on?
8. To meet our needs, what should we change in the sample meeting plans?

PARENTS CAN HELP WITH THE MATHEMATICS PROGRAM FEATURE BY:

1. Sharing their expertise
2. Providing transportation for the main event
3. Providing materials for the different games and activities
4. Mentoring youth as they work on advancement
5. Maintaining current Youth Protection certification, which is required of all adults providing transportation for or participating in outings.



AREAS OF MATHEMATICS

Mathematics is the study of numbers and their application to describing the world around us. We use numbers every day of our lives, sometimes without thinking about it. For example, when you glance at a clock, you instantly know what time it is without doing any conscious calculations.

Arithmetic is the study of quantity. It consists of counting and combining numbers through addition, subtraction, division, and multiplication.

Geometry deals with describing the shape, size, position, and physical characteristics of lines and solids.

Statistics is the study of collecting and analyzing data, while **probability** enables us to describe the likelihood of an event occurring. When combined, these two disciplines use knowledge from the past to try to predict what might happen in the future.

Calculate Your Horsepower. First find out how much you weigh in kilograms. Multiply your weight in pounds by 0.454 to get kilograms. Next, find a set of stairs. Measure the height (not the length) of the stairs from the bottom to the ending point at the top and write it down. Do this by multiplying the height of one stair by the number of stairs (it doesn't matter how long the stairs are).

Take a running start toward the stairs. When you step on the first step, start the timer; when both feet are on the top step, stop the timer. You may skip stairs. Now you have all the numbers needed.

Now calculate the Power (P) with this formula: mah/t (m*9.80*h)/t, where

- m = mass (your weight) in kilograms
- a = acceleration (9.80 m/sec2 is the acceleration caused by Earth's gravity)
- h = height of staircase in meters
- t = time in seconds

The number you get is in watts, which is equal to joules per second (J/s) and newton meters per second (Nm/s). If you don't divide by time, you will calculate the energy needed to climb the stairs.

Work = mah Power = mah/t

Work (or energy) is measured in newton meters or joules; power is measured in joules/second or watts. Divide the number of watts by 745.6 to get the number in horsepower.

AREAS OF STUDY IN MATHEMATICS

Mathematics has two main areas of study. Though they overlap, they can be broken down into general categories.

Raw Mathematics: The Study of Numbers

Quantity: The study of numerical representation

- Numbers
- Integers
- Rational numbers
- Real numbers
- Complex numbers

Structure: The study of sets and functions

- Combinatorics
- Number theory
- Group theory
- Graph theory
- Order theory
- Algebra

Space: The study of describing physical objects

- Geometry
- Trigonometry
- Differential geometry
- Topology
- Fractal geometry
- Measure theory

Change: The study of understanding how things behave

- Calculus
- Vector calculus
- Differential equations
- Dynamic systems
- Chaos theory
- Complex analysis

Applied Mathematics: The Application of Numbers and Models to the Real World

Actuarial science: The study of assessing risk

Biology: The study of life and living organisms

Business: The trade of goods or services

Chemistry: The study of the properties and changes of matter

Computer science: The study of computation

Economics: The study of the production, distribution, and consumption of goods

Engineering: The process of analyzing, designing, and building

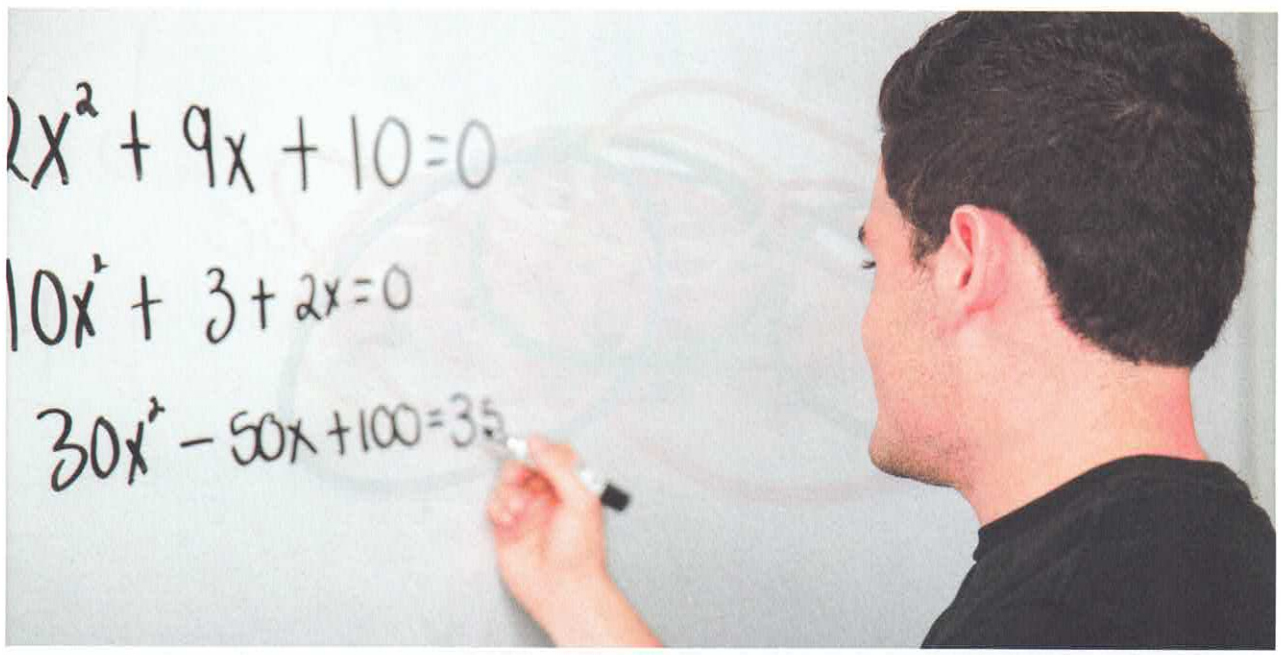
Operations research: The study of decision making

Physics: The study of matter and motion

Psychology: The study of mental functions and behaviors

Scientific computing: The study of construction models to solve scientific problems

Statistics: The study of collecting and analyzing data



BUNGEE JUMPING RUBBER BANDS

If you have ever watched bungee jumpers and wondered why they don't hit the ground, make this model to find an answer. This activity requires at least two people and works much better with a group of three to six people.

The scenario: The Acme Daredevil Adventure Company offers the bungee jumping experience to its clientele. The company has picked a site for bungee jumping. Your task is to simulate bungee jumping using rubber bands and an action figure (doll) to determine the ultimate length, or the number of rubber bands to be used with your action figure at any given height to guarantee a safe jump. For maximum thrills, the jump must allow your action figure to come as close to the floor as possible.

Set up the simulation. Tape a weight(s) to the doll's back so that it is heavy enough to stretch the rubber band "bungee cord." Tie one or two rubber bands (the unstretched size should be about 4 inches) to the doll's feet and drop it, headfirst, from various heights. Keep raising the jump height until the head no longer hits the floor. Once you reach this height, perform three trials: Measure the height of the drop each time, calculate the average, and calculate the maximum error between the average and the drop heights used to find that average. (Conduct a test drop several times to practice taking readings.) Continue adding rubber bands to see what the average drop height will be for different numbers of rubber bands. Do the experiment with at least six different quantities of rubber bands. Use a tabular chart to help you organize and record your data. (You may use Excel or create your own tables.)

MATHEMATICS GAMES

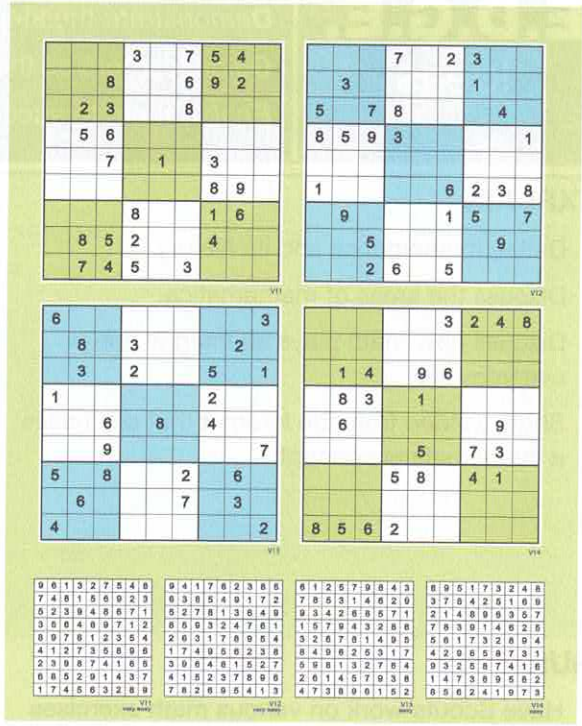
Time Bomb

How to play: Organize into groups of two to 10 people and have each group form a circle. The first person in the circle starts counting from 1 and says up to three numbers. (They could say, "1," "1, 2," or "1, 2, 3.") The next person in the circle continues the sequence by saying the next number in order, depending on what the first person said, and two or three additional numbers. Continue until someone is forced to say 12. That person is now out. Start again from 2. The last person standing is the winner.

Math Bingo

Equipment: A list of 24 math questions that all have different answers; a blank bingo card for each Scout (five rows and five columns with a star in the middle box); pens; projector, white-board, or easel pad

How to play: Display the answers to math questions and have the Scouts randomly place them on their bingo cards. Then, randomly select questions and display them for everyone to see. Have the participants solve the problems and mark the corresponding answer with an "X" on their cards. The winner gets the X's on the card to make a vertical, horizontal, or diagonal line, or to cover all four corners.



Sudoku Race

Equipment: Copies of Sudoku puzzles and small prizes

How to play: Explain the rules of Sudoku and give a puzzle to each person to solve. The first one to complete the puzzle correctly receives a prize. After everyone has completed the puzzle, lead a discussion on different strategies used to solve the puzzle.

Math Trivia

Equipment: A list of mathematical trivia questions and answers. Find questions and answers through an internet search or create your own.

How to play: There are two options: Teams take turns answering questions, or players write the answers on their own sheets 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.

E.D.G.E. Ideas

***E**xplain* how it is done—Tell them.
***D**emonstrate* the steps—Show them.
***G**uide* learners as they practice—Watch them do it.
***E**nable* them to succeed on their own—Have them practice/teach it.

EXPLAIN

- Define mathematics and its history.
- Discuss the areas of mathematics.
- Discuss how math plays an integral role in everyday life.
- Show a video from the internet that discusses a mathematical concept.

DEMONSTRATE

- Show a video of a "mathemagician" that demonstrates how mathematics can be fun.
- Invite a speaker to discuss how math is used in his or her career.
- Demonstrate the strength and stability of different shapes.
- Show how you can calculate how far something will travel.
- Demonstrate how you can predict an event through probability.

GUIDE

- Have Scouts work on various math exercises while you supervise.
- Lead a reflection on the different activities Scouts have conducted.
- Watch Scouts design and build mathematical-based games, offering guidance throughout the process.
- Have Scouts assist in planning the main event.
- Help Scouts identify an opportunity to teach or mentor another person.

ENABLE

- Challenge Scouts to improve a math skill they struggle with or to learn something new.
- Encourage older Scouts to mentor younger Scouts by helping them with their math homework.
- Have Scouts practice their math skills through worksheets and downloadable apps.
- Encourage Scouts to talk with their math teacher about careers that rely on math.

MAIN EVENT SUMMARIES

ESSENTIAL	CHALLENGING	ADVANCED
Day Activity	Day Activity	Weekend Activity
Architecture firm visit—Visit an architecture firm and have an associate demonstrate how mathematics plays an integral role in designing buildings. Go on a walking tour of your local community and see the different types of geometric shapes that are used in the construction of buildings.	Game show—Create a number of games that could be featured on a television show. These games should rely on mathematical concepts such as probability or arithmetic. Decide what prizes can be won. Host a game show for younger Scouts to participate in, and explain the math behind each game.	Math campout—Camp near a college campus where you can meet with math professors or students and participate in math-related activities.

MATHEMATICS

Meeting Plan: Introducing the Areas of Math

Week 1 Date_____

ACTIVITY	DESCRIPTION	RUN BY	TIME*
Preopening 15 minutes before meeting	Short videos of "mathemagic" as Scouts arrive.		6:45 p.m.
Opening Ceremony 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
Group Instruction 10 minutes	Discuss the following: • The definition of mathematics • The origins of mathematics and numerical systems • The areas of mathematics one can study and their importance		7:10 p.m.
Skills Instruction 40 minutes	• Arithmetic: Using the height of everyone in the unit, calculate the unit average. • Geometry: Go on a geometry scavenger hunt. • Probability and statistics: Estimate how many times heads or tails will occur when flipping a coin.		7:50 p.m.
	• Arithmetic: Play a game of dominoes. • Geometry: Create a building using simple geometric shapes. • Probability and statistics: Play a game of Yahtzee.		
	• Arithmetic: Construct a Caesar cipher to send and decode an encoded message. • Geometry: Estimate the height of a building using a protractor. • Probability and statistics: Construct a Galton board. What does it do? What can you learn from it?		
Breakout Groups 15 minutes	• New members practice basic Scout skills. • Older members choose a math-related merit badge or Nova award to work on together. • Review the last main event and discuss what could have made it better.		8:05 p.m.
Game 10 minutes	Play Time Bomb (described earlier).		8:15 p.m.
Closing 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
Total 90 minutes of meeting			
After the Meeting 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

*All times are suggested.

MATHEMATICS
Meeting Plan: Arithmetic

Week 2 Date_____

ACTIVITY	DESCRIPTION	RUN BY	TIME*
Preopening 15 minutes before meeting	Play a video (such as Disney's "Donald in Mathmagic Land") that discusses the basics of arithmetic.		6:45 p.m.
Opening Ceremony 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
Group Instruction 10 minutes	• Discuss the basic concepts of arithmetic. • Have Scouts give examples of ways they use arithmetic in their daily lives.		7:10 p.m.
Skills Instruction 35 minutes	Create a budget for your unit's main event. Try to figure out the total cost per person.		7:20 p.m.
	Play a game of dominoes and keep an accurate score.		
	Calculate the value of pi by using different round objects.		
Breakout Groups 15 minutes	• New members practice basic Scout skills. • Older members work on a math-related merit badge or Nova Award. • Make plans for participation in the main event.		7:55 p.m.
Game 15 minutes	Play Math Bingo (described earlier).		8:10 p.m.
Closing 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
Total 90 minutes of meeting			
After the Meeting 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

*All times are suggested.

MATHEMATICS

Meeting Plan: Going the Distance With Geometry

Week 3 Date_____

ACTIVITY	DESCRIPTION	RUN BY	TIME*
Preopening 15 minutes before meeting	Use newspapers to create towers. See which one can hold the most weight. Try to figure out what shapes are the strongest.		6:45 p.m.
Opening Ceremony 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
Group Instruction 10 minutes	Discuss the following: • What is geometry? • The concept of ratios and averages. • How geometry is used in the real world.		7:10 p.m.
Skills Instruction 40 minutes	• Have Scouts build paper airplanes and record the distance their planes fly. • Have them modify their design and vary the takeoff height to see which design flies the farthest. • Have each Scout calculate the average distance for each plane design.		7:20 p.m.
	• Have Scouts build paper airplanes and record both the distance their planes go (D) and the takeoff height (H). • Calculate the glide ratio (G) by dividing the distance by height (G = D / H). • Have the Scouts change a number of variables (design, takeoff height, throwing force) to find the best glide ratio. The larger the G is, the better!		
	• Have each Scout use graphing paper to draw a diagram of the plane's flight path. • Have them find an appropriate scale, and record the results from multiple trials. • See if Scouts notice from their drawings that a larger glide ratio leads to a greater distance traveled.		
Breakout Groups 15 minutes	• New members practice basic Scout skills. • Older members work on a math-related merit badge or Nova Award. • Make plans for participation in main event.		8 p.m.
Game 10 minutes	Play Sudoku Race (described earlier).		8:15 p.m.
Closing 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
Total 90 minutes of meeting			
After the Meeting 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

*All times are suggested.

MATHEMATICS

Meeting Plan: Predicting the Future With Probability and Statistics

Week 4 Date_____

ACTIVITY	DESCRIPTION	RUN BY	TIME*
Preopening 15 minutes before meeting	Show videos of probability tricks. Think about what game show segments you can use to demonstrate how probability can give the contestant an advantage to winning a prize.		6:45 p.m.
Opening Ceremony 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
Group Instruction 5 minutes	Do the following: • Explain what probability means. • Explain the concept of statistics. • Describe a few scenarios where probability and statistics can be used to predict future events.		7:10 p.m.
Skills Instruction 40 minutes	Using two dice, have each Scout calculate the probability of each possible sum. Roll the dice 100 times, and keep a tally of how many times each sum occurs. Have the participants compare the results to their calculations.		7:15 p.m.
	Create a survey about your upcoming main event. Survey your unit members and record their answers. Look to see if there are any surprises in the answers. Graph the survey results when appropriate. Determine whether the results warrant a change of plans.		
	Play a game of backgammon. Discuss how probability comes into play.		
Breakout Groups 15 minutes	• New members practice basic Scout skills. • Older members work on a math-related merit badge or Nova Award. • Confirm assignments for the main event.		7:55 p.m.
Game 15 minutes	Play Math Trivia (described earlier).		8:10 p.m.
Closing 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
Total 90 minutes of meeting			
After the Meeting 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

*All times are suggested.

MATHEMATICS

Main Event: Architecture Firm Visit

Date_____

Logistics

Location: _____

_____

Departure time: _____

Return time: _____

Duration of activity: 4 to 8 hours

Budget: Completed _____ Approved _____

Camping: Duty roster_____ Menu _____

Transportation: Group _____ Self_____

Essential (Tier I)

Visit an architecture firm and have an associate demonstrate how mathematics plays an integral role in designing buildings. Take a walking tour of your local community and look for different types of geometric shapes used in the construction of buildings.

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 an architecture or construction firm near you. • Contact the firm to arrange a talk about the work they do, and a tour of one of their projects. • Walk around and observe other buildings in your community. • Learn all you can about how the buildings were constructed and how math was used in their creation. Visiting a construction site will require advance planning. You will need permission from your parents, unit leader, the architect, and the construction site manager. A construction site is a very dangerous place. While there, you will need to closely follow the site manager's directions and comply with all the safety procedures, including wearing a hard hat, protective eyewear, and proper footwear.
Safety	• Use the buddy system. • Have a first-aid kit available. • Cellphones are a good idea. • Two-deep adult leadership is required for all activities.

Notes

MATHEMATICS

Main Event: Game Show

Date_____

Logistics

Location: _____

_____

Departure time: _____

Return time: _____

Duration of activity: 4 to 8 hours

Budget: Completed _____ Approved _____

Camping: Duty roster_____ Menu _____

Transportation: Group _____ Self_____

Challenging (Tier II)

Create a number of games that could be featured on a television show. These games should rely on mathematical concepts such as probability or arithmetic. Decide what prizes can be won. Host a game show for a group such as a Scout troop or Cub Scout pack to participate in, and explain the math behind each game.

Equipment List	• Decided-upon uniform • Materials to build games • Prizes • Lunch (decide on individual or group) • Speaker system • Pad and paper for taking notes • Camera
Activity	• Watch a number of game shows to see how math is used to win or to increase the chance of winning a prize. • Build some games that demonstrate probability or math concepts. • Figure out how your game show will run, who your contestants will be, the objectives of each game, and the rules for each game. • Decide which prizes will be given out. • Rehearse the game show before the actual event.
Safety	• Use the buddy system. • Have a first-aid kit available. • Cellphones are a good idea. • Two-deep adult leadership is required for all activities.

Notes

MATHEMATICS

Main Event: Math Campout

Date_____

Logistics

Location: _____

_____

Departure time: _____

Return time: _____

Duration of activity: Weekend

Budget: Completed _____ Approved _____

Camping: Duty roster_____ Menu _____

Transportation: Group _____ Self_____

Advanced (Tier III)

Camp near a college campus where you can meet with math professors or students and participate in math-related activities.

Equipment List	• Materials for activities • Textbooks • Camping gear • First-aid kit • Meal plan • Water • Scout Basic Essentials (Review the list and take what you need.)
Activity	• Identify a college campus where the group can meet with professors or students on the weekend. • Identify a nearby camping location. (The backyard of the math building might be ideal; be sure to get permission in advance.) • Develop a schedule of tours and other math-related activities. Activities could include measuring distances around campus; calculating the height or volume of buildings; conducting surveys in the student union and generating statistics; repeating some of the activities from the weekly meeting plans (like building paper airplanes); keeping statistics at a sporting event; or doing activities that lead to a Nova or Supernova award. • Build in time for fun and basic Scout skills. • Make appropriate assignments.
Safety	• Use the buddy system. • Follow campus safety policies. • Have a first-aid kit available. • Cellphones are a good idea. • Two-deep adult leadership is required for all activities.

Notes

RESOURCES AND REFERENCES

Books

Architecture, Aviation, Chess, Cooking, Digital Technology, Drafting, Electronics, Energy, Engineering, Entrepreneurship, Game Design, Home Repairs, Metalwork, Model Design and Building, Nuclear Science, Orienteering, Personal Management, Pioneering, Programming, Robotics, Salesmanship, Surveying, Welding, and *Woodwork* merit badge pamphlets

Nova Awards guidebooks

Clemens, Glenn. *The Everything Kids' Math Puzzles Book: Brain Teasers, Games, and Activities for Hours of Fun.* Adams Media, 2003.

The Exploratorium. *Exploratopia: More than 400 Kid-Friendly Experiments and Explorations for Curious Minds.* Little, Brown Books for Young Readers, 2006.

Overholt, James L., and Laurie Kincheloe. *Math Wise!: Over 100 Hands-On Activities That Promote Real Math Understanding, Grades K–8.* Jossey-Bass, 2010.

Websites

Are You Game?: Explorations in Probability
Website: www.actuarialfoundation.org/portfolio/are-you-game/

Modeling And Simulation Tools for Education Reform
Website: www.shodor.org/master

STEM Resources
Website: www.nea.org/tools/lessons/stem-resources.html

Videos

Arthur Benjamin, "A Performance of 'Mathemagic'"
Website: www.ted.com/talks/arthur_benjamin_does_mathemagic.html

"Donald in Mathmagic Land"
Website: www.amazon.com/dp/B00287Z1F2

Galton Board Assembly Instructions
Website: www.mathscareers.org.uk/video/galton-board-assembly-instructions/

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