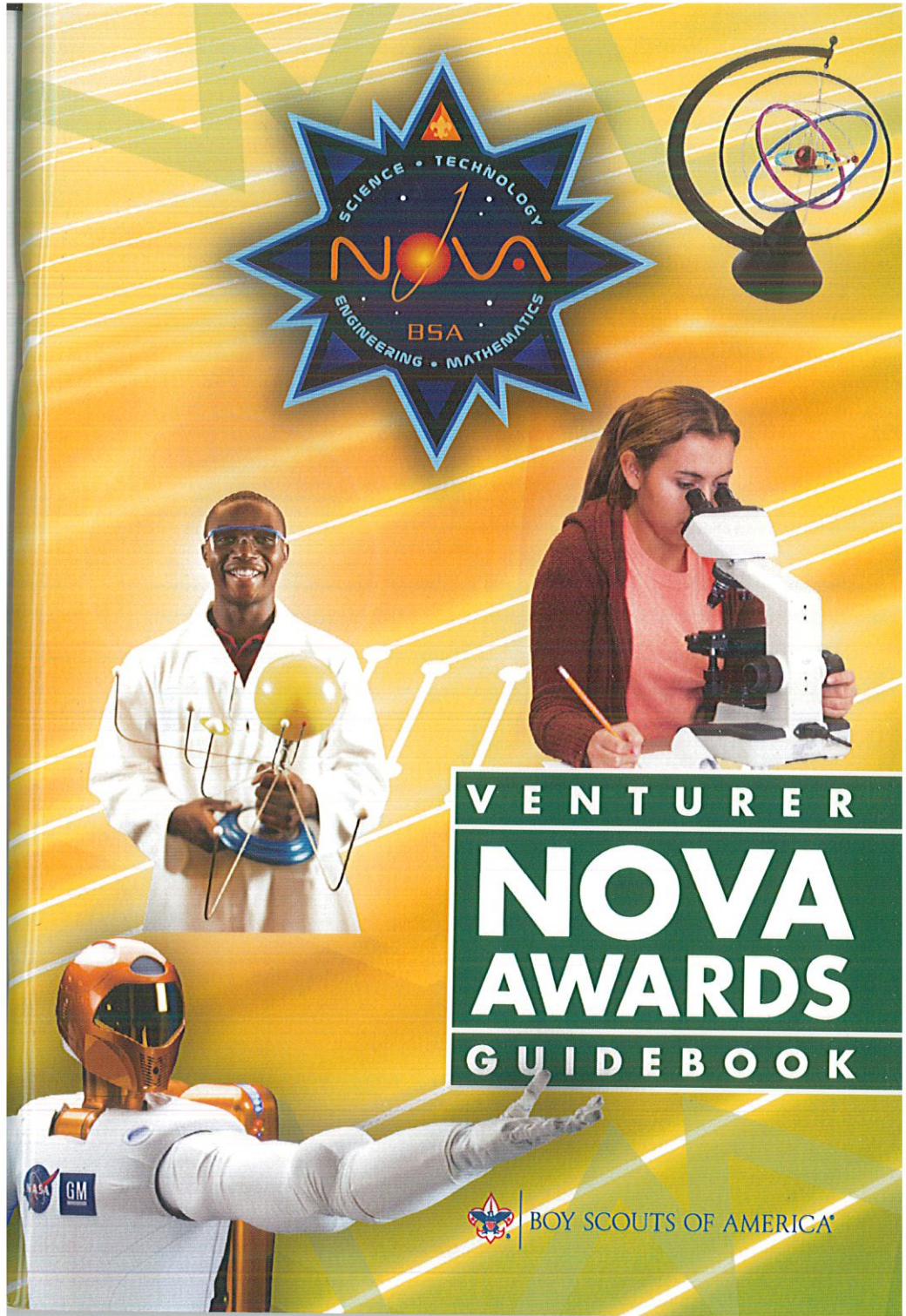
SCIENCE • TECHNOLOGY
NOVA
BSA
ENGINEERING • MATHEMATICS
VENTURER
NOVA
AWARDS
GUIDEBOOK
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Letter From Dr. Bernard Harris

When I was 13, I was struck by the grandeur of Apollo 11 (the first flight of humans to the moon) and the boldness of two men walking on the moon for the first time. I overcame the challenges of my childhood to achieve success as a physician, NASA astronaut, and entrepreneur. Education was my launching pad.

America has long prided itself as a nation of dreamers, a land where everyone can strive for a better life, a place where grand achievements like attending top-notch universities and missions to the moon, and inventions like personal computers and the Internet spring forth to create new prosperity. The Boy Scouts of America has provided you with an opportunity to enhance your STEM knowledge and experience with the Nova awards. These awards, while providing hands on experiences, also connect with other Scout accomplishments.

We must not lose the will to pursue daring new goals, encourage Venturers like you to dream, and equip them with the educational tools to pursue their aspirations. Our future depends on it.

Go for your Nova and Supernova awards. Go, BSA!

Dr. Bernard Harris
Astronaut, physician, entrepreneur

Contents

Introduction

Welcome to the *Venturer Nova Awards Guidebook!* The Nova Awards program is Scouting's newest and most exciting adventure. The acronym "STEM" focuses on ***s***cience, ***t***echnology, ***e***ngineering, and ***m***athematics. Venturers around the world can explore the wonders of different STEM fields as they work toward a Nova or Supernova award.

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

Structure of the Program

The Nova and Supernova awards are available to all Venturers. The awards are optional. Requirements must be completed while registered as a Venturer (with two exceptions as noted below) and before aging out.

There are four Nova awards—one for each of the STEM areas. With slight variations, the Venturer Nova awards are equivalent to the Boy Scout Nova awards. Therefore, Nova awards in the same STEM field cannot be earned in both programs.

Thus, Venturers can earn Nova awards in all fields for which they do not already have a Boy Scout Nova award. Completion of any Nova award earns the Venturer the right to wear the Nova award patch. Completion of each additional Nova award is recognized by a pi (π) pin placed on the patch. Each of these awards builds on STEM-related explorations involves hands-on activities and often includes a field trip. The activities are roughly comparable in scope, difficulty, and effort to Boy Scout merit badges, but with more freedom of choice. The four Nova awards for Venturers are:

- Launch!
- Power Up
- Hang On!
- Numbers Don't Lie

The Supernova awards include activity topics. An activity topic is a two-part, hands-on, high-level activity related to one of the STEM fields. Part 1 involves research, preparation, set up, coordination, and/or organization. Part 2 involves analysis and reflection, culminating in the creation of a report in any one of the available format options. See the "Supernova Activity Topics" chapter.

There are three Supernova awards for Venturers—first-, second-, and third-level awards—with each level being a prerequisite for the next. With slight variations, the first two levels of the Venturer Supernova awards are equivalent to the two levels of the Boy Scout Supernova awards. Therefore, Venturers who earned a Boy Scout Supernova award while a Boy Scout may use that to satisfy a prerequisite for the Venturer Supernova award at the next higher level.

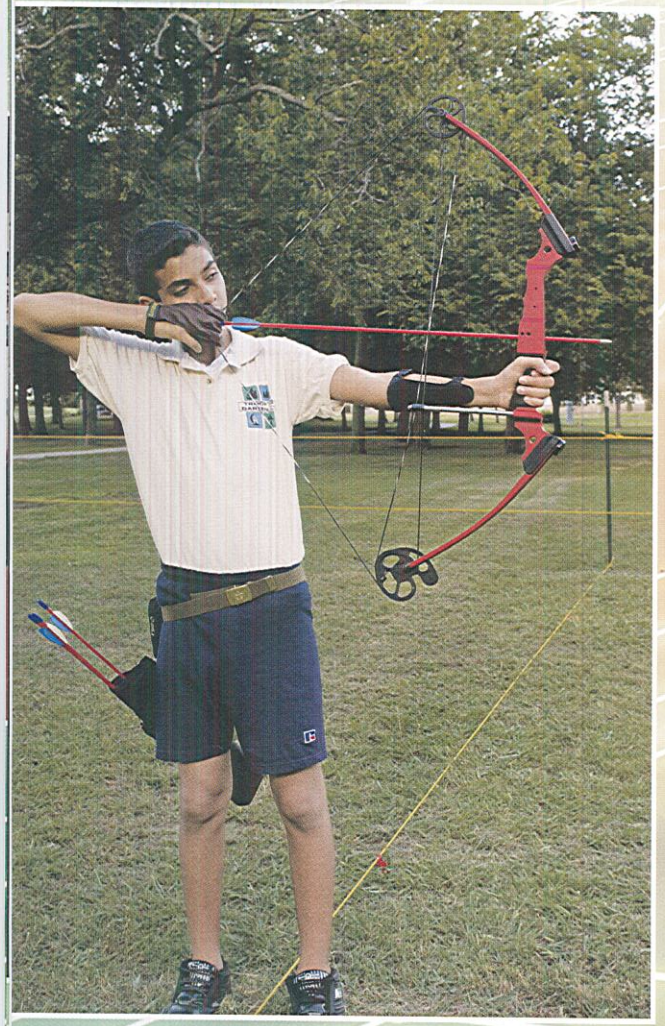
The Supernova awards recognize superior achievement in the STEM fields and require significantly more effort by the Venturer than the Nova awards. In particular, the third-level Supernova award is best suited for college students, although it is attainable for highly motivated high school students. For all Supernova awards, a mentor, who serves much like a merit badge counselor, is required. Completion of a Supernova award earns the Venturer the right to wear the appropriate Supernova medal. Each of these awards involves completion of STEM-related explorations, completion of Nova awards, and extensive independent work. The Supernova awards are:

- Dr. Sally Ride Supernova Award (first level)
- Wright Brothers Supernova Award (second level)
- Dr. Albert Einstein Supernova Award (third level)

Guidebook Resources

This *Venturer Nova Awards Guidebook* has a section for adult counselors and mentors to guide Venturers as they fulfill requirements for each award. This chapter, "A Guide for Nova Award Counselors and Supernova Award Mentors," includes basic information and resource suggestions about many of the requirements. There is also website support at www.scouting.org/stem, which will be periodically updated.

With this guidebook, Nova counselors and Supernova mentors have the resources to help guide Venturers on the path to achievement of Nova and Supernova awards, and more importantly, to build big dreams for their future.



Launch!

This module is designed to help you explore how science affects your life each day.

1. Choose A *or* B *or* C and complete ALL the requirements.
   A. Watch about three hours total of science-related shows or documentaries that involve projectiles, aviation, weather, astronomy, or space technology. Then do the following:
      (1) Make a list of at least two questions or ideas from each show.
      (2) Discuss two of the questions or ideas with your counselor.

Some examples include—but are not limited to—shows found on PBS ("NOVA"), Discovery Channel, Science Channel, National Geographic Channel, TED Talks (online videos), and the History Channel. The NASA website at www.nasa.gov has some short multimedia clips that involve projectiles, aviation, space, weather, astronomy, or aviation or space technology. You may choose to watch a live performance or movie at a planetarium or science museum instead of watching a media production. You may watch online productions with your counselor's approval and under your parent's supervision.

   B. Read (about three hours total) about projectiles, aviation, space, weather, astronomy, or aviation or space technology. Then do the following:
      (1) Make a list of at least two questions or ideas from each article.
      (2) Discuss two of the questions or ideas with your counselor.

Examples of magazines include—but are not limited to—*Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover, Air & Space, Popular Astronomy, Astronomy, Science News, Sky & Telescope, Natural History, Robot, Servo, Nuts and Volts,* and *Scientific American.*

   C. Do a combination of reading and watching (about three hours total). Then do the following:
      (1) Make a list of at least two questions or ideas from each article or show.
      (2) Discuss two of the questions or ideas with your counselor.

2. Choose ONE STEM field of interest from the following list. Complete ALL the requirements for a Venturing STEM exploration in that field. See pages 27–29 for the requirements. (If you have already completed a Venturing STEM exploration in one of these fields, please choose a different field for this award.)

Archery	Aviation	Robotics	Space Exploration
Astronomy	Rifle Shooting	Shotgun Shooting	Weather
Athletics			

3. Choose A *or* B and complete ALL the requirements.
   A. Simulations. Find and use a projectile simulation applet on the Internet (with your parent's or guardian's permission). Then design and complete a hands-on experiment to demonstrate projectile motion.
      (1) Keep a record of the angle, time, and distance.
      (2) Graph the results of your experiment. (Note: Using a high-speed camera or video camera may make the graphing easier, as will doing many repetitions using variable heights from which the projectile can be launched.)

Helpful Links

Be sure you have your parent's or guardian's permission before using the Internet. Some of these websites require the use of Java runtime environments. If your computer does not support this program, you may not be able to visit those sites.

Projectile Motion Applets
Website: http://www.mhhe.com/physsci/physical/giambattista/proj/projectile.html

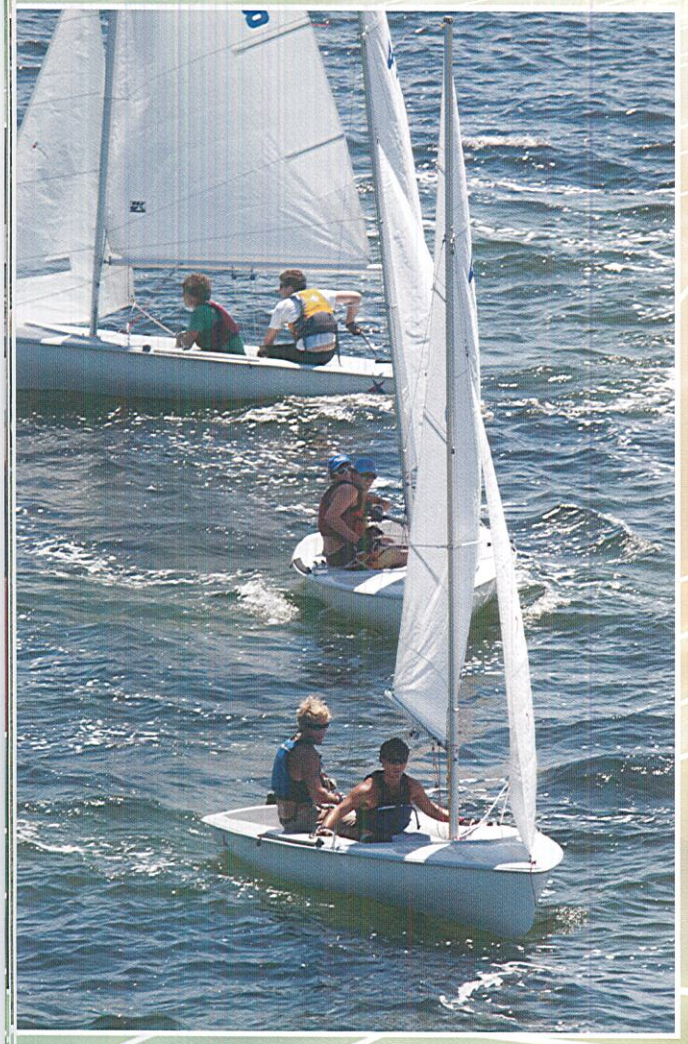
Fowler's Physics Applets
Website: http://galileoandeinstein.physics.virginia.edu/more_stuff/Applets/ProjectileMotion/enapplet.html

Java Applets on Physics
Website: http://www.walter-fendt.de/ph14e/projectile.htm

      (3) Discuss with your counselor:
         (a) What a projectile is
         (b) What projectile motion is
         (c) The factors affecting the path of a projectile
         (d) The difference between forward velocity and acceleration due to gravity
   B. Discover. Explain to your counselor the difference between escape velocity (not the game), orbital velocity, and terminal velocity. Then answer TWO of the following questions. (With your parent's or guardian's permission, you may explore websites to find this information.)
      (1) Why are satellites usually launched toward the east, and what is a launch window?
      (2) What is the average terminal velocity of a skydiver? (What is the fastest you would go if you were to jump out of an airplane?)
      (3) How fast does a bullet, baseball, airplane, or rocket have to travel in order to escape Earth's gravitational field? (What is Earth's escape velocity?)

4. Choose A *or* B and complete ALL the requirements.
   A. Visit an observatory or a flight, aviation, or space museum.
      (1) During your visit, talk to a docent or person in charge about a science topic related to the site.
      (2) Discuss your visit with your counselor.
   B. Discover the latitude and longitude coordinates of your current position. Then do the following:
      (1) Find out what time a satellite will pass over your area. (A good resource to find the times for satellite passes is the Heavens Above website at www.heavens-above.com.)
      (2) Watch the satellite using binoculars. Record the time of your viewing, the weather conditions, how long the satellite was visible, and the path of the satellite. Then discuss your viewing with your counselor.
5. Choose A *or* B *or* C and complete ALL the requirements.
   A. Design and build a catapult that will launch a marshmallow a distance of 4 feet. Then do the following:
      (1) Keep track of your experimental data for every attempt. Include the angle of launch and the distance projected.
      (2) Make sure you apply the same force everytime, perhaps by using a weight to launch the marshmallow.

      Discuss your design, data, and experiments—both successes and failures—with your counselor.
   B. Design a pitching machine that will lob a softball into the strike zone. Answer the following questions, then discuss your design, data, and experiments—both successes and failures—with your counselor.
      (1) At what angle and velocity will your machine need to eject the softball in order for the ball to travel through the strike zone from the pitcher's mound?
      (2) How much force will you need to apply in order to power the ball to the plate?
      (3) If you were to use a power supply for your machine, what power source would you choose and why?
   C. Design and build a marble run or roller coaster that includes an empty space where the marble has to jump from one part of the chute to the other. Do the following, then discuss your design, data, and experiments—both successes and failures—with your counselor.
      (1) Keep track of your experimental data for every attempt. Include the vertical angle between the two parts of the chute and the horizontal distance between the two parts of the chute.
      (2) Experiment with different starting heights for the marble. How do the starting heights affect the velocity of the marble? How does the starting height affect the jump distance?
6. Discuss with your counselor how science affects your everyday life.



Power Up

This module is designed to help you explore how technology affects your life each day.

1. Choose A *or* B *or* C and complete ALL the requirements.
   A. Watch about three hours total of technology-related shows or documentaries that involves transportation or transportation technology. Then do the following:
      (1) Make a list of at least two questions or ideas from each show.
      (2) Discuss two of the questions or ideas with your counselor.

Some examples include—but are not limited to—shows found on PBS ("NOVA"), Discovery Channel, Science Channel, National Geographic Channel, TED Talks (online videos), and the History Channel. You may choose to watch a live performance or movie at a planetarium or science museum instead of watching a media production. You may watch online productions with your counselor's approval and under your parent's supervision.

   B. Read (about three hours total) about transportation or transportation technology. Then do the following:
      (1) Make a list of at least two questions or ideas from each article.
      (2) Discuss two of the questions or ideas with your counselor.

Examples of magazines include—but are not limited to—*Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover, Air & Space, Popular Astronomy, Astronomy, Science News, Sky & Telescope, Natural History, Robot, Servo, Nuts and Volts,* and *Scientific American.*

C. Do a combination of reading and watching (about three hours total). Then do the following:
   (1) Make a list of at least two questions or ideas from each article or show.
   (2) Discuss two of the questions or ideas with your counselor.

2. Choose ONE STEM field of interest from the following list. Complete ALL the requirements for a Venturing STEM exploration in that field. See pages 27–29 for the requirements. (If you have already completed a Venturing STEM exploration in one of these fields, please choose a different field for this award.)

Automotive Maintenance	Farm Mechanics
Aviation	Motorboating
Canoeing	Nuclear Science
Cycling	Railroading
Drafting	Small-Boat Sailing
Electricity	Space Exploration
Energy	Truck Transportation

3. Do ALL of the following.
   A. Using the requirements from the above list of STEM explorations:
      (1) Tell your counselor the energy source(s) used in these STEM explorations.
      (2) Discuss the pros and cons of each energy source with your counselor.
   B. Make a list of sources of energy that may be possible to use in transportation.
   C. With your counselor:
      (1) Discuss alternative sources of energy.
      (2) Discuss the pros and cons of using alternative energy sources.
4. Design and build a working model vehicle (not from a kit).
   A. Make drawings and specifications of your model vehicle before you begin to build.
   B. Include one of the following energy sources to power your vehicle (do not use gasoline or other combustible fuel source): solar power, wind power, or battery power.
   C. Test your model. Then answer the following questions:
      (1) How well did it perform?
      (2) Did it move as well as you thought it would?
      (3) Did you encounter problems? How can these problems be corrected?
   D. Discuss with your counselor:
      (1) Any difficulties you encountered in designing and building your model
      (2) Why you chose a particular energy source
      (3) Whether your model met your specifications
      (4) How you would modify your design to make it better
5. Discuss with your counselor how technology affects your everyday life.

Hang On!

This module is designed to help you explore how engineering affects your life each day.

1. Choose A *or* B *or* C and complete ALL the requirements.
   A. Watch about three hours total of engineering-related shows or documentaries that involve motion or motion-inspired technology. Then do the following:
      (1) Make a list of at least two questions or ideas from each show.
      (2) Discuss two of the questions or ideas with your counselor.

Some examples include—but are not limited to—shows found on PBS ("NOVA"), Discovery Channel, Science Channel, National Geographic Channel, TED Talks (online videos), and the History Channel. You may choose to watch a live performance or movie at a planetarium or science museum instead of watching a media production. You may watch online productions with your counselor's approval and under your parent's supervision. One example is the NOVA Lever an Obelisk page on ancient Egypt and the use of levers, available at http://www.pbs.org/wgbh/nova/egypt/raising/lever.html.

   B. Read (about three hours total) about motion or motion-inspired technology. Then do the following:
      (1) Make a list of at least two questions or ideas from each article.
      (2) Discuss two of the questions or ideas with your counselor.

Examples of magazines include—but are not limited to—*Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover, Air & Space, Popular Astronomy, Astronomy, Science News, Sky & Telescope, Natural History, Robot, Servo, Nuts and Volts,* and *Scientific American.*

C. Do a combination of reading and watching (about three hours total). Then do the following:
   (1) Make a list of at least two questions or ideas from each article or show.
   (2) Discuss two of the questions or ideas with your counselor.

2. Choose ONE STEM field of interest from the following list. Complete ALL the requirements for a Venturing STEM exploration in that field. See pages 27–29 for the requirements. (If you have already completed a Venturing STEM exploration in one of these fields, please choose a different field for this award.)

Archery	Inventing
Aviation	Model Design and Building
Composite Materials	Railroading
Drafting	Rifle Shooting
Electronics	Robotics
Engineering	Shotgun Shooting

Composites can be found just about everywhere: in airplanes and sports cars, golf clubs and guitars, boats and baseball bats, bathtubs and circuit boards, and even bridges. Composites make bicycles and skis lighter, kayaks and fishing poles stronger, houses warmer, and helmets tougher." Choose one of these items for your discussion to answer requirement 3c.

3. Do ALL of the following:
   A. Make a list or drawing of the six simple machines.
   B. Be able to tell your counselor the name of each machine and how each machine works.

Helpful Links

"Six Simple Machines": ConstructionKnowledge.net

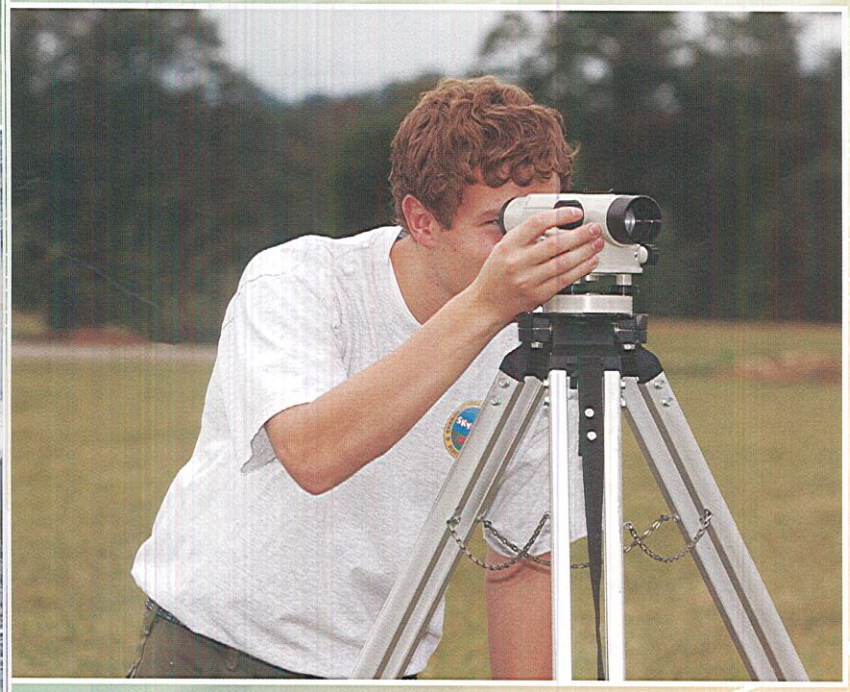
Website: http://www.constructionknowledge.net/general_technical_knowledge/general_tech_basic_six_simple_machines.php

   C. Discuss the following with your counselor:
      (1) The simple machines that were involved with the motion in your chosen STEM exploration (Hint: Look at the moving parts of an engine to find simple machines.)
      (2) The energy source causing the motion for the subject of your STEM exploration
      (3) What you learned about motion from doing the STEM exploration

4. Choose A *or* B and complete ALL the requirements.
   A. Visit an amusement park. Then discuss the following with your counselor:
      (1) The simple machines present in at least two of the rides
      (2) The forces involved in the motion of any two rides
   B. Visit a playground. Then discuss the following with your counselor:
      (1) The simple machines present in the playground equipment
      (2) The forces involved in the motion of any two playground fixtures

5. Do the following:
   A. On your own, design one of the following and include a drawing or sketch: an amusement park ride OR a playground fixture OR a method of transportation.
   B. Discuss with your counselor:
      (1) The simple machines present in your design
      (2) The energy source powering the motion of your creation

6. Discuss with your counselor how engineering affects your everyday life.



Numbers Don't Lie

This module is designed to help you explore how math affects your life each day.

1. Choose A *or* B *or* C *or* D and complete ALL the requirements.
   A. Watch about three hours total math-related shows or documentaries that involve scientific models and modeling, physics, sports equipment design, bridge building, or cryptography. Then do the following:
      (1) Make a list of at least two questions or ideas from each show.
      (2) Discuss two of the questions or ideas with your counselor.

Some examples include—but are not limited to—shows found on PBS ("NOVA"), Discovery Channel, Science Channel, National Geographic Channel, TED Talks (online videos), and the History Channel. You may choose to watch a live performance or movie at a planetarium or science museum instead of watching a media production. You may watch online productions with your counselor's approval and under your parent's supervision.

   B. Research (about three hours total) several websites (with your parent's or guardian's permission) that discuss and explain cryptography or the discoveries of people who worked extensively with cryptography. Then do the following:
      (1) List and record the URLs of the websites you visited and the major topics covered on the websites you visited. (You may use the copy and paste function—eliminate the words—if you include your sources.)
      (2) Discuss with your counselor how cryptography is used in the military and in everyday life and how a cryptographer uses mathematics.

Helpful Link

"The Mathematics of Cryptology": University of Massachusetts
Website: http://www.math.umass.edu/~gunnells/talks/crypt.pdf

   C. Read at least three articles (about three hours total) about physics, math, modeling, or cryptography. You may wish to read about how technology and engineering are changing sports equipment, how and why triangles are used in construction, bridge building, engineering, climate and/or weather models, how banks keep information secure, or about the stock market. Then do the following:
      (1) Make a list of at least two questions or ideas from each article.
      (2) Discuss two of the questions or ideas with your counselor.

Examples of magazines include—but are not limited to—*Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover, Air & Space, Popular Astronomy, Astronomy, Science News, Sky & Telescope, Natural History, Robot, Servo, Nuts and Volts,* and *Scientific American.*

D. Do a combination of reading, watching, or researching (about three hours total). Then do the following:
   (1) Make a list of at least two questions or ideas from each article, website, or show.
   (2) Discuss two of the questions or questions with your counselor.

2. Choose ONE STEM field of interest from the following list. Complete ALL the requirements for a Venturing STEM exploration in that field. See pages 27–29 for the requirements. (If you have already completed a Venturing STEM exploration in one of these fields, please choose a different field for this award.) After completion, discuss with your counselor how the Venturing STEM exploration you completed uses mathematics.

American Business	Drafting	Personal	Surveying
Chess	Entrepreneurship	Management	Weather
Computers	Orienteering	Radio	

3. Choose TWO from A *or* B *or* C *or* D *or* E and complete ALL the requirements. (Write down your data and calculations to support your explanation to your counselor. You may use a spreadsheet. Do not use someone else's data or calculations.)
   A. Calculate your horsepower when you run up a flight of stairs.
      (1) How does your horsepower compare to the power of a horse?
      (2) How does your horsepower compare to the horsepower of your favorite car?
      Share your calculations with your counselor, and discuss what you learned about horsepower.

Helpful Links

"How to Calculate Your Horsepower": wikiHow
Website: http://www.wikihow.com/Calculate-Your-Horsepower

"Lab Power": Haplosciences.net
Website: http://onlinephys.com/labpower1.html

   B. Attend at least two track, cross-country, or swim meets.
      (1) For each meet, time at least three racers. (Time the same racers at each meet.)
      (2) Calculate the average speed of the racers you timed. (Make sure you write down your data and calculations.)
      (3) Compare the average speeds of your racers to each other, to the official time, and to their times at the two meets you attended.
      Share your calculations with your counselor, and discuss your conclusions about the racers' strengths and weaknesses.

   C. Attend a soccer, baseball, softball, or basketball game. Choose two players and keep track of their efforts during the game. (Make sure you write down your data and calculations.) Calculate their statistics using the following as examples:
      (1) Soccer—Goals, assists, corner kicks, keeper saves, fouls, offsides
      (2) Baseball or softball—Batting average, runs batted in, fielding statistics, pitching statistics
      (3) Basketball—Points, baskets attempted, rebounds, steals, turnovers, and blocked shots
      Share your calculations with your counselor, and discuss your conclusions about the players' strengths and weaknesses.
   D. Attend a football game or watch one on TV. (This is a fun activity to do with a parent or friend!) Keep track of the efforts of your favorite team during the game. (Make sure you write down your data and calculations.) Calculate your team's statistics using the following as examples:
      (1) Kicks/punts
         (a) Kickoff—Kick return yards
         (b) Punt—Number, yards
         (c) Field goals—Attempted, percent completed, yards
         (d) Extra point—Attempted, percent completed
      (2) Offense
         (a) Number of first downs
         (b) Forward passes—Attempted, percent completed, total length of passes, longest pass, number and length of passes caught by each receiver, yardage gained by each receiver after catching a pass
         (c) Running plays—Number, yards gained or lost for each run, longest run from scrimmage line, total yards gained or lost, and number of touchdowns
      (3) Defense—Number of quarterback sacks, interceptions turnovers, and safeties
      Share your calculations with your counselor, and discuss your conclusions about your team's strengths and weaknesses.
   E. How starry are your nights? Participate in a star count to find out. This may be done alone but is more fun with a group. Afterward, share your results with your counselor.
      (1) Visit NASA's Student Observation Network website (with your parent's or guardian's permission) at www.nasa.gov/audience/foreducators/son/energy/starcount/ for instructions on performing a star count.
      (2) Do a star count on five clear nights at the same time each night.
      (3) Report your results on NASA's Student Observation Network website (with your parent's or guardian's permission) and see how your data compares to others.

4. Do ALL of the following.
   A. Investigate your calculator and explore the different functions.
   B. Discuss the functions, abilities, and limitations of your calculator with your counselor. Talk about how these affect what you can and cannot do with a calculator. (See your counselor for some ideas to consider.)
5. Discuss with your counselor how math affects your everyday life.

Venturing STEM Explorations

The following requirements apply to any specific STEM field of interest chosen by a Venturer in the course of completing a Nova or Supernova award.

Safety Considerations

Discuss with your mentor the following safety issues in the field of interest you have chosen.

1. The kinds of hazards (to humans, to the environment, to animals) that might occur while engaged in activities in this field
2. Appropriate safety precautions to help minimize these risks
3. Whether it is necessary to obtain training in safety protocols in this field
4. The agencies or organizations that can provide such training
5. What it would take to be a certified safety specialist or safety trainer in this field

Developing Knowledge

Do ONE of the following.

1. Visit a workplace in this field. Ask to see an example of the work that is done there, the different facilities, and the tools used. After your visit, discuss the following with your mentor:
   A. How much work is done manually and how much work is done with the aid of technology
   B. How much work is done by individuals and how much is done in cooperation with others
   C. The ways in which the fields of science, technology, engineering, and/or mathematics are important to the work done in this business

Visitations will require advance planning by the Venturer with assistance from the counselor. The counselor should call ahead to make arrangements, and make plans to have appropriate supervision of all Venturers. The site will very likely have rules and instructions that must be followed. The counselor should help ensure that all the participants are aware of and follow those rules. This may include safety procedures and other instructions.

2. Using resources you find on your own such as at the library, on the Internet, or through visits to relevant places of learning, such as museums, learn more about this field. Then discuss the following with your counselor:
   A. The historical development of this field
   B. How tools and techniques have evolved over time
   C. How modern tools and techniques have changed over time in this field and how its capacity for accomplishment has been affected
   D. The ways in which science, technology, engineering, and/or mathematics are important to this field

Hands-On Experiences

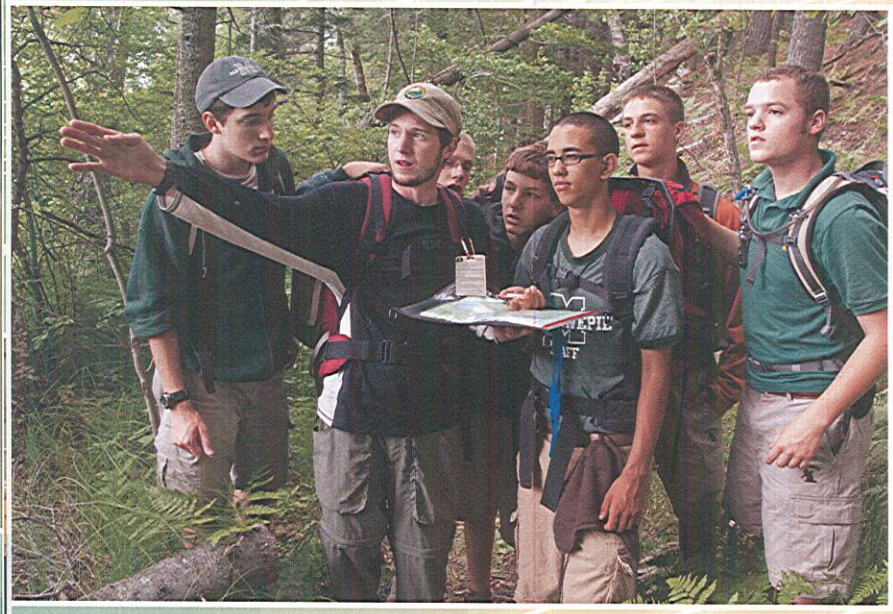
In consultation with your counselor and, if necessary, a consultant who is a specialist in this field, identify four hands-on activities that are examples of work done in this field that you could carry out yourself. Each activity should engage your attention and efforts for approximately three hours. Under the supervision of appropriate specialists and observing the highest standards of safety, carry out all four activities. Discuss with your counselor what you learned during each activity. Examples include—but are not limited to—conducting experiments, building models, designing tools, drawing plans, learning how to use tools, and serving as an assistant/apprentice to a specialist.

Career Exploration

Find out about three career opportunities in this field. Communicate to your counselor the training, education, and experience that are needed for each career.

Value and Impact

Using a combination of library research, Internet research (with your parent's or guardian's permission), and interviews with experts, find out how important the role of this field is in addressing the problems facing our modern world: a burgeoning worldwide population, stresses on the environment, ongoing issues of basic health and sustenance, or other concerns. How might knowledge, abilities, and capacity in this field bring about positive change on a significant scale? Create an oral or written report and present it to your counselor.



Venturer Supernova Awards

You must be a Venturer to earn a Venturer Supernova award. With your parent's and unit leader's help, you must select a council-approved mentor who is a registered Scouter. You may NOT choose your parent or your unit leader (unless the mentor is working with more than one youth).

A Note to the Mentor

The Venturer Supernova awards recognize superior achievement by a Venturer in the fields of science, technology, engineering, and mathematics (STEM). All experiments or projects should be conducted using the highest level of safety protocol and always under the supervision of a qualified, responsible adult.

These STEM exploration topics are approved for earning the Venturer Supernova awards:

Animal Science
Archaeology
Architecture
Astronomy
Automotive Maintenance
Aviation
Bird Study
Chemistry
Composite Materials
Computers
Dentistry
Drafting
Electricity
Electronics
Energy
Engineering
Environmental Science
Farm Mechanics
Fish and Wildlife Management
Forestry
Gardening
Geocaching
Geology
Insect Study
Inventing
Mammal Study
Medicine
Nature
Nuclear Science
Oceanography
Plant Science
Pulp and Paper
Radio
Reptile and Amphibian Study
Robotics
Scuba Diving
Soil and Water Conservation
Space Exploration
Surveying
Veterinary Medicine
Weather
Welding

Dr. Sally Ride Supernova Award

First-Level Supernova Award for Venturers

1. Complete THREE of the Venturer Nova Awards. (Note: These may be done at any time after becoming a Venturer.)
2. Complete the Venturing Scholarship exploration.
   A. Do ONE of the following:
      1. Show that you have had an average grade of B or higher (80 percent or higher) for one term or semester.
      2. Show that for one term or semester you have improved your school grades over the previous period.
   B. Do TWO of the following:
      1. Discuss with your mentor the following situation: Suppose you are writing a research paper and you find a resource in which the author's words are so perfectly aligned with your perspectives and understanding that you cannot imagine a better way to put it in your paper than to use the author's own words. How can you handle such a situation while still maintaining scholarly integrity?
      2. Discuss with your mentor the following situation: Suppose you are writing a research paper and you find resources with conflicting "facts" and/or conflicting conclusions. What are some viable strategies for resolving these conflicts and deciding which resources are trustworthy?
      3. Discuss with your mentor the following situation: Suppose you are writing a research paper and have acquired dozens of resources. How would you keep track of the resources, summarize the salient parts of each resource, and synthesize the collection of resources into a coherent research paper?
   C. Get a note from an instructor* of yours that states that during the past term you have demonstrated satisfactory abilities or progress in independently completing scholarly endeavors and proactively seeking help when needed.
   D. Do ONE of the following:
      1. Show that you have taken part in a scholarly activity (in school or in Scouting) that required teamwork, and discuss with your mentor what you learned about how a team of people can work together effectively, fairly, and efficiently.
      2. Find three resources (online, in a library, personal interview, etc.) of expert advice on successful teamwork strategies and discuss with your mentor what you learned about how a team of people can work together effectively, fairly, and efficiently.
   E. Do ONE of the following:
      1. Write an argument of approximately 500 words that defends or opposes the principle that, "Students should be obligated to report instances of cheating by others." Discuss this with your mentor.

**If you are home-schooled, you may obtain a note from a counterpart such as your parent. If you are near the end of your current term, you may ask a current instructor. Otherwise, you should ask an instructor from the immediate past term.*

2. With your crew, another crew, school class, or another peer group, conduct an ethical controversy discussion that addresses the question, "Should students be obligated to report instances of cheating by others?"
3. Using the guidelines found in the "Venturing STEM Explorations" chapter, complete STEM explorations for four of the topics listed above. (Note: These may be completed at any time after becoming a Venturer.)

A Supernova activity topic is a two-part, hands-on, high-level activity related to one of the STEM fields. Part 1 involves research, preparation, set up, coordination, and/or organization. Part 2 involves analysis and reflection, culminating in the creation of a report in any one of the available format options. See the "Supernova Activity Topics" chapter for more information about activity topics.

4. Complete TWO Supernova activity topics, one each in two different STEM areas.
5. Participate in a local, state, or national science fair or mathematics competition OR in any equally challenging STEM-oriented competition or workshop approved by your mentor. An example of this would be an X-Prize type competition.
6. Do ONE of the following:
   A. Spend at least one day "shadowing" a local scientist or engineer. After your visit, discuss with your mentor your experience and what you learned about STEM careers.
   B. Learn about a career that is heavily involved with STEM. Make a presentation to your mentor about what you learned.
7. Working with your mentor, organize and present a Nova award or other STEM-related program at a Cub Scout den or pack meeting. Be sure to receive permission from the appropriate unit leader, and plan accordingly. If a Cub Scout den or pack is not available, your presentation may be given to another youth group.
8. Review the scientific method (you may know this as the scientific process) and note how scientists establish hypotheses, theories, and laws. Compare how the establishment of "facts" or "rules" using the scientific method differs from the establishment of "facts" or "rules" in other environments, such as legal, cultural, religious, military, mathematical, or social environments. Then do each of the following:
   A. Choose a current subject with at least two competing theories on the subject and learn as much as possible about each theory. Analyze the competing theories, decide which one is most convincing to you, and explain why to your mentor.
   B. Make a presentation to your mentor that describes the controversy, the competing theories, and your conclusions about how the scientific method can or cannot contribute to the resolution of the controversy.
9. Submit an application to the district or council Nova or advancement committee for approval.

Wright Brothers Supernova Award

Second-Level Supernova Award for Venturers

Option 1: For those who earned the Ride Supernova Award as a Venturer

1. Earn the Dr. Sally Ride Supernova Award while a registered Venturer.
2. Complete ONE additional Venturer Nova award for a total of four. (Note: This may be done at any time after becoming a Venturer.)
3. Using the guidelines found in the "Venturing STEM Explorations" chapter, complete FOUR of the topics listed above. The four topics must be different from those completed while working on the Dr. Sally Ride Supernova Award, for a total of eight different topics. (Note: These awards may be earned at any time after becoming a Venturer.)
4. Complete TWO additional Supernova activity topics, one each in the two STEM areas *not* completed for the Dr. Sally Ride Supernova Award. (Note: The intent is that upon completion of the Wright Brothers Supernova Award, the Venturer will have completed one Supernova activity topic in each of the four STEM areas.)
5. Participate in a local, state, or national science fair or mathematics competition OR any other equally challenging STEM-oriented competition or workshop approved by your mentor. An example of this would be an X-Prize type competition. (Note: The intent is that upon completion of the Wright Brothers Supernova Award, the Venturer will have participated in two such events.)
6. Working with your mentor, organize and present a Nova awards or other STEM-related program at a Cub Scout den or pack meeting. Be sure to receive permission from the appropriate unit leader. If a Cub Scout den or pack is not available, your presentation may be given to another group. (Note: The intent is that upon completion of the Wright Brothers Supernova Award, the Venturer will have completed two such presentations.)
7. Research a scientific, technical, engineering, or mathematical breakthrough or invention of the past 100 years that has affected our society in a meaningful way. Develop your hypothesis on how this invention might further affect our society during your lifetime. Present either a 30-minute oral report *or* a 1,500-word written report to your mentor.
8. Submit an application to the district or council Nova or advancement committee for approval.

Option 2: For those who earned the Harris Supernova Award as a Boy Scout

1. Earn the Dr. Bernard Harris Supernova Award while a registered Boy Scout.
2. Complete ONE additional Venturer Nova award for a total of four. (Note: This may be done at any time after becoming a Venturer.) The Venturer Nova award completed should be different from the Boy Scout Nova awards previously completed.
3. Using the guidelines found in the "Venturing STEM Explorations" chapter, complete FOUR of the topics listed above. The four topics must be different from those completed while working on the Dr. Bernard Harris Supernova Award, for a total of eight different topics. (Note: These awards may be earned at any time after becoming a Venturer.) Additional merit badges earned while a Boy Scout may **not** be used in lieu of the STEM explorations required for this award.
4. Complete TWO additional Supernova activity topics, one each in the two STEM areas *not* completed for the Harris Supernova Award. (Note: The intent is that upon completion of the Wright Brothers Supernova Award, the Venturer will have completed one Supernova activity topic in each of the four STEM areas.)
5. Participate in a local, state, or national science fair or mathematics competition OR any other equally challenging STEM-oriented competition or workshop approved by your mentor. An example of this would be an X-Prize type competition. (Note: The intent is that, upon completion of the Wright Brothers Supernova Award, the Venturer will have participated in two such events.)
6. Working with your mentor, organize and present a Nova award or other STEM-related program to a Cub Scout den or pack meeting. Be sure to receive permission from the appropriate unit leader. If a Cub Scout den or pack is not available, your presentation may be given to another youth group. (Note: The intent is that upon completion of the Wright Brothers Supernova award the Venturer will have completed two such presentations.)
7. Research a scientific, technical, engineering, or mathematical breakthrough or invention of the past 100 years that has affected our society in a meaningful way. Develop your hypothesis on how this invention might further affect our society during your lifetime. Present either a 30-minute oral report *or* a 1,500-word written report to your mentor.
8. Submit an application to the district or council Nova or advancement committee for approval.

Dr. Albert Einstein Supernova Award

Third-Level Supernova Award for Venturers

1. Earn either the Thomas Edison Supernova Award while a registered Boy Scout *or* the Wright Brothers Supernova Award while a registered Venturer.
2. Complete FOUR additional Supernova activity topics, one in each of the four different STEM areas. (Note: The intent is that upon completion of the Dr. Albert Einstein Supernova Award the Venturer will have completed two Supernova activity topics in each of the four STEM areas for a total of eight.)
3. Create and propose a new Nova awards topic for any program (Cub Scout, Webelos, Boy Scouts, or Venturing) comparable to the existing Nova awards topics at that program level. Prepare a written outline for this proposed Nova awards topic and submit it to your mentor.
4. With guidance from your mentor, select an area of current STEM-related concern and develop a research project or experiment related to that area. This research project or experiment should be challenging and should require a significant investment of time and effort on your part. (A guideline would be approximately 100 hours.) If your mentor is not a specialist in the area of your project or experiment, he or she will solicit assistance from a specialist to serve as a STEM consultant. Execute the project or experiment. Prepare a complete and well-documented written report AND an oral presentation. Present both to your mentor and your local council Nova committee.
5. Submit an application to the national Nova committee for approval.

Supernova Activity Topics

Each STEM field—science, technology, engineering, mathematics—offers a choice of three Supernova activity topics. These are two-part, hands-on, high-level activities created to challenge you and help you continue along your STEM journey to excellence. Part 1 involves research, preparation, set up, coordination, and/or organization. Part 2 includes elements such as analysis, reflection, experimentation, design, or invention, and culminates in a report created by you.

Report Format Options

No matter what STEM activity you choose, you will need to *create a report*. Reports are a regular part of the work of professionals in STEM fields, so this will be good preparation for future career demands. Notice it doesn't say *write a report*. You are not restricted to just writing a report, although you may choose to do so if you like. Any report will probably involve some writing, but the report itself may be created and presented in any number of ways. Use your imagination!

You may choose from any format below for your report, or you may create a combination of formats. You may create something entirely new as long as your Supernova mentor approves. The objective is for you to communicate to others in a way that helps them understand what you have learned and how you learned it.

- Oral report
- Written report
- Poster presentation
- Virtual poster (See www.Glogster.com for ideas.)
- Video production
- Multifaceted format
- Any format of your own design, with your mentor's advance approval

The report must provide sufficient detail so that someone unfamiliar with the topic can understand the content. For each format, you can incorporate a variety of ways to present your information and may use technology to create a polished presentation. For example, an oral report might include a PowerPoint presentation, or a poster presentation might include a slide show. Be creative.

A Note About Resources

The books and websites provided for each superactivity topic are presented as optional resources and are merely suggestions. In most cases, they are *not* crucial to the corresponding activities. The Boy Scouts of America makes no guarantee that they will be available in local public libraries, from booksellers, or online.

The resources represent examples of the types you might use to support your work on a particular activity. You may very well find alternative and/or additional resources that serve you as well or better than those presented here.

Supernova Activity Topic: Science

If you are fascinated by how things work and you want to help contribute to a better planet Earth, the Supernova activity topic choices for science give you a hands-on chance to:

- Reduce your environmental impact on Earth.
- Explore the wonders of space technology.
- See why carbonation and candy create an explosive experiment.

Choose any *one* of these activities and discover how it drives your imagination, your curiosity, and your fascination with science.

Environmental Science: New Things From Old

This activity can be done individually or in a group. Your task is to investigate the logistics and environmental value of recycling and repurposing used items into new products and to invent a product that is predominantly made from used item(s).

Part 1: Research

1. Find two products made primarily from recycled materials. Describe the recycling process and the production process for each of these products. Discuss with your mentor:
   A. The impact of these recycled products on the environment compared with the impact of the same products made with all-new materials
   B. The environmental impact of the two products regarding pollution control and remediation, such as hazardous byproducts in the air, water, and waste
   C. The environmental impact of the two products regarding resource conservation and management, such as animal life, plant life, water, fuel, and protected lands/sites
   D. The environmental impact of the two products regarding production infrastructure, such as land use, municipal planning, transportation, and energy

Part 2: Product Invention and Report

1. Develop your own design for a product that can be made by recycling or repurposing other items. The items being recycled or repurposed should form the bulk of the new product. For instance, avoid designs that are 5 percent recycled and 95 percent new materials. Use ONE of the following two approaches.
   A. Find an item that isn't environmentally friendly, doesn't break down easily, and is typically thrown away. Invent a new product that would repurpose that item. The recycling of tires into road surfacing material and into playground mulch is an example of this approach.
   B. Think of an often-used product that is typically made with all-new materials. Develop a way to make that product out of recycled or repurposed materials. (The production of paper grocery bags made from recycled paper instead of "new" paper is an example of this approach.)
2. Summarize design specifications of the product you invented for requirement 1, and create a drawing, model, or prototype. What resources would be needed to carry out a large-scale production of your invention? Speculate on the environmental impact of using your product over a comparable product made with all-new materials. Create a report that includes your design specifications, photos or illustrations, a summary of how your product can be mass produced, and a case for the environmental soundness of your product.

Resources

Susan Casey. *Kids Inventing! A Handbook for Young Inventors* (for younger youth). Jossey-Bass, 2005.

Russel Gehrke. *Recycling Projects for the Evil Genius* (lots of how-tos). McGraw-Hill/TAB Electronics, 2010.

Garth Johnson. *1000 Ideas for Creative Reuse: Remake, Restyle, Recycle, Renew* (pretty pictures, good inspiration, no how-tos). Quarry Books, 2009.

Movie "Science": Misconceptions, Misunderstandings, and Mistakes

This activity can be done individually or in a group. There are many popular movies and television shows with plots that involve space travel in the near or distant future. Your task in this activity is to watch one such production and identify scientific or technological advances that appear to be possible and those that appear to be impossible and explain.

Part 1: Research

1. View a movie or television show involving space, space travel, or life in space. In the movie or show, identify two instances of scientific "principles" or technological "advances" that violate currently accepted scientific principles or misrepresent currently available technology. Discuss the following with your mentor:
   A. The scientific principle that is violated and how. Describe the technology that is misrepresented and how.
   B. Two potentially plausible technological or scientific advances in your chosen movie—show and explain how these could potentially come to be in the future. Discuss the hurdles that would have to be overcome in order to develop those advances.
   C. The scientifically based reasoning that leads you to believe scientists, engineers, mathematicians, and technology specialists can overcome these hurdles.

Part 2: Report

Create a report that is addressed to the producers of your chosen movie or show, from the perspective of a scientist hired as a consultant on the production. Include suggestions for the producers to make the movie more scientifically or technologically accurate, realistic, and plausible.

Resources

Jeanne Cavelos. *The Science of Star Wars: An Astrophysicist's Independent Examination of Space Travel, Aliens, Planets, Robots as Portrayed in the Star Wars Films and Books*. St. Martin's Griffin, 2000.

Michio Kaku. *Physics of the Impossible: A Scientific Exploration Into the World of Phasers, Force Fields, Teleportation, and Time Travel*. Anchor, 2009.

Lawrence M. Krauss. *The Physics of Star Trek*. Basic Books, 2007.

Tom Rogers. *Insultingly Stupid Movie Physics: Hollywood's Best Mistakes, Goofs and Flat-Out Destructions of the Basic Laws of the Universe*. Sourcebooks Hysteria, 2007.

Household Chemistry: Diet Coke and Mentos Explosions

This activity can be done individually or in a group, but it is much more fun as a group. For this experiment, you will investigate how and why dropping a Mentos candy into a two-liter bottle of Diet Coke creates a massive explosion.

Part 1: Research and Experiment Design

Research this Diet Coke and Mentos phenomenon by doing the following:

1. Find out what others have discovered about how and why this experiment works. Note who discovered what about the experiment. Keep track of your references and resources.
2. Formulate a hypothesis that you would like to test.
3. Design an experiment to test your hypothesis. Be sure to get approval from your mentor prior to conducting your experiment. Make sure your plans for the experiment include an outside location, a list of supplies needed (which should be inexpensive, readily available, and safe), adequate safety protocols and equipment (safety goggles, etc.), plans for accurate and precise measurements, a list of step-by-step procedures, number of trials, and plans for recording and analysis of data.

Part 2: Experiment and Report

Conduct your experiment. You might want to videotape your experimental trials and include some video clips in your final report.

1. Discuss the following with your mentor:
   A. What happened during the experiment.
   B. How the evidence supported or contradicted your hypothesis.
   C. Whether the experiment raised any new questions for you.
   D. Whether something unexpected happened during the experiment. Tell how what happened might suggest about a future experiment on this same phenomenon.
2. Create a report that describes your hypothesis, experiment, and conclusions. (For guidance, see "Report Format Options" earlier in this section.)

Resources

Theodore Gray. *Theo Gray's Mad Science: Experiments You Can Do at Home—But Probably Shouldn't*. Black Dog & Leventhal Publishers, 2011.

Robert Bruce Thompson. *Illustrated Guide to Home Chemistry Experiments: All Lab, No Lecture*. O'Reilly Media, 2008.

Using your favorite search engine online (with your parent's or guardian's permission), enter search terms EepyBird, Mythbusters, and "Diet Coke and Mentos."

Supernova Activity Topic: Technology

From the energy that keeps our homes comfortable and our lights on, to the communication that lets us talk to people around the world, to the special effects used in the movies, we depend on technology. Choose any *one* of the following projects and you will have fun while learning about today's technology.

Energy Technology

This activity can be done individually or in a group. The technology to harness energy has always been a significant factor in human progress. The harnessing of energy from wind, sun, water, biomass, fossil fuels, and other sources has evolved dramatically over time.

Part 1: Field Trip

Arrange and go on a field trip to a site where you can learn about innovative and/or historical examples of energy production, storage, and use and the ways people are making such processes sustainable. Possible sites include power plants, fuel manufacturers or refineries, power generation sites, energy- or resource-efficient buildings, historical sites of energy use or production, educational centers, museums, and so on.

Part 2: Analysis and Report

1. Create a report that describes your field trip and what you learned.
2. For the energy production and/or use that you chose, find out about the current state of technology, its course in historical that led to today's technology, and future directions for this technology. Discuss the following with your mentor.
   A. The effect on the environment, our natural resources, and our economy of our current methods
   B. Whether current methods are sustainable over the long term

Resources

John Perlin. *From Space to Earth: The Story of Solar Electricity*. Harvard University Press, 2002.

Terry S. Reynolds. *Stronger than a Hundred Men: A History of the Vertical Water Wheel*. The Johns Hopkins University Press, 2002.

Robert W. Righter. *Wind Energy in America: A History*. University of Oklahoma Press, 2008.

Communication Technology

This activity can be done individually or in a group. It requires the participation of 20 to 30 people.

The scenario: You are the communication chair for a science fair being organized by your unit. Your responsibility is to gather contact information from all participants (contestants, judges, staff, and so on) and formulate a communication plan that will be effective for anticipated communications and necessary-but-unexpected communications as well. You will need to be able to communicate some information to everyone, other information to subgroups, and additional information to another group of individuals.

Part 1: Communication Plan

Before you get started, share your plan with your mentor. Then do the following:

1. Solicit volunteers to serve as participants. Give each participant a mock role in your mock science fair. You will need 20 to 30 such individuals.
2. From each participant, gather at least two ways to contact him or her, as well as an emergency contact. Participants should list their contact modes in order, from the most-likely-to-be-received to the least-likely-to-be-received.
3. Set up plans for how you will broadcast messages to various subgroups, how you will get emergency messages to groups or individuals who will have access to the contact information, how access will be maintained, and back-up plans in case you are suddenly unavailable.

Think about the kinds of information you will need to communicate. This sometimes influences the mode of communication and should also be a part of your communication plans.

4. Test your plan by playing a few Mad Libs via your communication plan. To test your communication plan, choose a particular Mad Lib and send out requests for various types of words (verbs, adjectives, nouns, and so on) to a group of individuals and subgroups. Make sure you cover your entire set of recipients or recipient groups, and be sure to give everyone a deadline for a response.

If you don't get responses, follow up with additional messages, perhaps via different communication modes. When you have what you need, make sure you communicate the finished Mad Lib back to the relevant individuals.

A Mad Lib is an unfinished story that is complete except for missing words, indicated by blanks. The words for each blank are in categories such as verbs, nouns, and adjectives. Missing words are supplied by folks who don't know the story, thus creating a funny, crazy, mad story.

Part 2: Analysis and Report

Gather some statistics relevant to your communication plan and your participants. Then do the following:

1. Discuss with your counselor:
   A. The many distinct modes of communication your participants used
   B. Any modes of communication used but with which you were unfamiliar
   C. The technology used for your broadcast communication messages and whether that technology was the most effective mode of communication for one-on-one messages
2. Create a report that outlines your communication plan, how you implemented it, and how effective it was. Include information about the biggest hurdle, anything unexpected that happened, and what you would do differently if this had been a real assignment for you.

Resources

Roger Price. *Best of Mad Libs.* Price Stern Sloan, 2008.

Roger Price and Leonard Stern. *More Best of Mad Libs.* Price Stern Sloan, 2009.

For information about Mad Libs, go to www.madlibs.com. Click on the "Mad Libs Online Widget" to try it out.

Entertainment Technology

This activity can be done individually or in a group. Many of today's movies involve extensive use of technology to create illusions of magnificent landscapes, mythical beasts, epic battle scenes, and so on. This activity involves learning about some of these technologies and applying them in a real-life setting.

Part 1: Building Knowledge

Choose a favorite, recent movie that is heavily laden with special effects, available for home viewing, and accompanied by supplemental material that describes and shows how the special effects were created. After you have chosen a movie, do the following:

1. Watch and study the material on the special effects.
2. Do some supplemental research on some of these special effects to build your understanding of them.
3. Choose one scene in the movie, or even one frame, and describe in detail to your mentor how that scene or frame was put together using various special effects.
4. Discuss with your mentor which of the special effects *you* would implement (even if just crudely) if you were to take a still photo or make a short video and wanted to give the illusion of something magnificent or unusual happening.

Part 2: Creating a Grand Illusion

Develop a plan for creating a still photo or a short video that would require special effects to convey the image or action that you desire to show. Be sure you share your plan with your mentor before you get started. For a still photo, make a crude sketch of what you want the photo to look like. For a video, make a storyboard of the action sequence.

A storyboard is a sequence of rough illustrations that depict the primary scenes or action shots of your story.

In either case, describe the special effects you would use to create each element of the piece. Discuss the following with your mentor:

1. What you would do first and how.
2. The sequence of special events and how everything goes together in the end. Do as many of the parts of the photo or video yourself as possible and describe what would best be done by highly trained and/or educated professionals.

The elements of the video/photo that you created must be planned and implemented using the highest safety protocols. Have your mentor examine your plan and suggest improvements. Your mentor must approve it before you get started. Create a report that shows your understanding of special effects and how they might be applied to the photo or video that you envisioned.

Resources

Troy Lanier and Clay Nichols. *Filmmaking for Teens: Pulling Off Your Shorts*. Michael Wiese Productions, 2010.

Richard Rickett. *Special Effects: The History and Technique.* Billboard Books, 2007.

Steve Wolf. *The Secret Science Behind Movie Stunts & Special Effects*. Skyhorse Publishing, 2007.

Supernova Activity Topic: Engineering

Have you ever studied how your bicycle works? To learn how a bicycle is put together (or engineered), here is a project for disassembling one. Or what about making a high-performance paper glider? Or having a contest to see who can drop a raw egg without breaking it? Choose any *one* of these activities to learn more about engineering.

Deconstruct and Analyze: Mechanical Designs

This activity can be done individually or in a small group. Your task is to take apart a bicycle (or other suitably complex mechanical device; see the note below), analyze the components, and describe how the components work (both separately and together).

Part 1: Preplanning and Set-Up

1. Do the following:
   A. With your mentor's assistance, choose an unwanted older bicycle—or any other complex mechanical device—perhaps not completely in working order, that is a bit beyond what you feel comfortable dismantling.
   B. Find a location for the project where you can take things apart, leave the pieces undisturbed, and come back another time.
   C. Determine and gather the necessary tools. You are encouraged to find resources to help you with the deconstruction, such as written instructions or a repair specialist willing to volunteer his/her time. (The specialist cannot touch the object or the parts, or handle the tools during dismantling. You and any fellow youth must do all of the dismantling.)

Part 2: Deconstruction, Analysis, and Report

This next phase involves deconstructing the device. Take pictures as you work, and make notes of what is happening in each picture.

1. Determine the following:
   A. The major components of the bicycle
   B. What parts make up each component
   C. How the components work together
   D. The mechanical or electronic advantages that a minimum of three parts or circuits convey

It is not crucial for the object you deconstruct to be a bicycle. Any mechanical device, machine, or tool will do, as long as it is suitably complex for your abilities and knowledge and is approved by your mentor. Examples include but are not limited to manual typewriters, old clocks, old sewing machines, and so on.

If you wish to deconstruct something that is electronic in nature (rather than just mechanical), then you will need to learn about additional safety protocols that must be observed while deconstructing electronics. Your mentor may suggest and help to secure the help of a qualified electronics expert for those projects. You must demonstrate to your mentor that you know and understand these additional safety protocols prior to beginning your deconstruction.

Whatever you choose to deconstruct, you must adapt the questions above to suit the object you are deconstructing and address those questions in your report.

2. Discuss the following with your mentor:
   A. What might cause a failure in one of the components
   B. The kinds of failures that can be fixed if you are using the device away from home (for example, if you are out mountain biking)
   C. The basic elements of keeping the device well maintained
   D. Considering the intended owner/user and uses of this device, discuss improvements to the design that could be made.
3. Create a report that communicates your understanding of the experience and addresses the following points.
   A. Document the deconstruction process, your analysis of the components, and how they work together
   B. Document your analysis of failure possibilities plus maintenance requirements, and what these suggest about design improvements

Resources

Bryan Bergeron. *Teardowns: Learn How Electronics Work by Taking Them Apart*. McGraw-Hill/TAB Electronics, 2010.

Naval Education and Training Program. *Basic Machines and How They Work*. Dover Publications, 1997.

Build and Test: High Performance Paper Gliders

This activity can be done individually, but works much better with at least two people. Your task is to measure how differences in design affect the flight characteristics of a glider. You will accomplish this by building and testing some high-performance paper gliders. These gliders use a laminated construction method that helps simulate a real glider much more closely than a simple folded piece of paper.

Part 1: Background Research, Baseline Design Selection, and Test

1. Research and discuss the following with your mentor:
   A. The fundamental parts of a glider
   B. The basic elements of the physics of stable flight
2. Choose a glider design from a kit or plans. *(You do not need to design the glider yourself.)* Then do the following:
   A. Identify one quantitative characteristic to test, such as flight distance, flight time, average flight speed, and so on. Then identify one qualitative characteristic to test, such as presence of a stall, dive, flip, left turn, right turn, and so on.
   B. Hypothesize how variations in one part of the glider, such as wing size, fuselage length, center of gravity, flap size, and so on, might influence these characteristics of the glider's performance.
   C. Build four high-performance gliders, identical except for variations in the relevant glider part.
   D. Establish a consistent method to measure each characteristic during a test flight. Then find a way to launch the gliders in a consistent manner so that they are launched at the same speed every time. You should perform test flights with each model five to six times to account for variations in flight performance. Try to keep the conditions of each test flight the same as for all the other test flights. Keep records of the results for each test flight.

Part 2: Analyze and Report

Present to your mentor your recorded data in a tabular format as well as a graphical format. (You may use Excel if you wish.) Then do the following:

1. Evaluate the data and determine how the variations in the tested glider part influenced the flight characteristics you observed. Based on the data you gathered, predict how the glider would perform relative to the flight characteristics you observed if you were to build a glider with another variation in the same glider part.
2. Suggest an ideal design of your tested glider part that would maximize the glider's performance relative to the flight characteristics you observed and explain your reasoning for this design.
3. Create a report that describes your glider, the flight tests, the flight data, and your conclusions. Include the procedures you followed to ensure consistent test conditions.
4. Share the flight records and data you have gathered with your mentor. Discuss what you have learned.

Source: The idea for this activity is based on the work of Andrew Olson, Ph.D., *Science Buddies, What Makes a Good Aerodynamic Design? Test Your Ideas with High-Performance Paper Gliders*. Visit www.sciencebuddies.org/science-fair-projects/project_ideas/Aero_p009.shtml.

Resources

Science 85 Magazine. *The Paper Airplane Book: The Official Book of the Second Great International Paper Airplane Contest* (best book for laminated paper techniques). Science 85 Magazine, 1985.

Hubert Smith. *The Illustrated Guide to Aerodynamics* (for background research). McGraw-Hill Professional, 1991.

AG Industries WhiteWings
Website: http://www.whitewings.com (glider kits)

NASA Beginner's Guide to Aeronautics
Website: http://www.grc.nasa.gov/WWW/K-12/airplane/guided.htm
(For background research, look at the gliders section.)

The Online Paper Airplane Museum
Website: http://www.theonlinepaperairplanemuseum.com (free glider plans)

Zovirl Industries
Website: http://www.zovirl.com (For glider plans, click on the *Paper Airplanes* tag.)

Design and Redesign: Egg Drop Contest

This is a group activity and requires at least two youth. Your task is to design a container in which to place a raw egg, so that when the container with the egg is dropped, the egg survives the impact without breaking.

Part 1: Research, Design, and Contest Set-Up

Research and describe to your mentor:

1. The physical forces affecting the outcome of an egg drop test
2. Desirable characteristics of container materials
3. Rules for other egg drop contests. (With your parent's or guardian's permission, search online.)
4. As a group, come to a consensus about the constraints and rules for your egg drop contest. Adopt, adapt, or make up your own rules. You might want to break into divisions, each with its own rules. (Youth with stronger STEM backgrounds should adopt more challenging constraints and rules.) Here are some guidelines. You must:
   A. Agree on constraints that the egg container must meet, such as dimensions, weight, allowable materials, disallowed elements, and so on.
   B. Agree on rules to ensure fairness, such as judging decisions, conditions for elimination, scoring system, how to win, and so on. You may wish to have several different ways to win.
   C. Communicate the constraints and competition rules to all participants.
   D. Design and build your container.
   E. Have fun—conduct the contest!

Part 2: Analysis, Redesign, and Report

Analyze how your container performed, and discuss with your mentor your design strategy and how well the container you designed performed. Then do the following:

1. Given your container's performance, your knowledge of the physical forces acting on it during a test drop, and your observations of other participants' containers and results, *redesign* your container. Your redesigned container should still fit within the contest constraints but offer improved performance.
2. Consider whether you would alter the constraints, how, and why. Create a report that communicates your understanding of the experience and addresses the following points.
   A. Describe your original egg container, your original design strategy, and your analysis of its performance.
   B. Describe your redesigned container and the reasoning that led to your new model.

Resources

Leonardo Da Vinci Egg Drop Devices
Website: http://www.niemworks.com/else/eggdrop.html (This site shows beautiful devices designed to look like Leonardo Da Vinci built them.)

3-Egg Drop Challenge
Website: http://teachertech.rice.edu/Participants/pschweig/eggdrop.html (Look here for rules that offer a more challenging contest.)

Winston-Salem/Forsythe County Egg Drop Competition
Website: http://wsfceggdrop.com (This site includes a nice set of rules that utilizes a mathematical formula to determine a winner, based on several design and performance factors.)

Supernova Activity Topic: Mathematics

Have you ever watched bungee jumpers and wondered why they don't hit the ground? You can make a model of your own and figure it out. Or, what about the Yellowstone geyser Old Faithful—how can you tell when it will erupt? What about voting—can you imagine how so many people in so many states can go in, cast a vote, and come out with a fair result? Mathematics is the key. Choose any *one* of these projects to learn how it's done.

From Simulations to Real Life: Modeling Bungee Jumping

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 provides rock climbing, skydiving, extreme skiing, and cliff diving adventures to the public. To appeal to a broader market, the board decided to add bungee jumping to its list of offerings. The details of this new venture now need to be worked.

The company has several sites planned for bungee jumping, and each site has a different jump height. 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.

Part 1: Set-Up and 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 numbers of rubber bands. Use a tabular chart to help you organize and record your data. (You may use Excel or create your own tables.)

Scatter plots use horizontal and vertical axes on a graph to plot data points and show how much one variable (or measurable "value") is affected by another. Each variable can be represented on the scatter plot with a dot. Once the scatter plot has been filled in with a number of dots, you should be able to see how the variables are "scattered" to show a trend. To learn more about scatter plots, use your favorite search engine on the Internet (with your parent's or guardian's permission), or ask your mentor.

Part 2: Analysis and Report

1. Create a scatter plot of ordered pairs of the type (number of rubber bands, average drop height). You may do this by hand or using data analysis software, such as Excel.
2. Using the scatter plot you have created, determine whether the points appear to lie on or near a line. Find such a line. If your mathematics background is not yet extensive, then find such a line by "eyeballing it" and drawing it onto the scatter plot with a ruler. Otherwise use a graphing calculator or data analysis software of your choice to find the line of best fit for your data.
3. Describe to your mentor how to use the line (graphical form or symbolic form) to make predictions. Then complete the following sentence (hypothesis): "If the height of the drop is _____, then I predict that the number of rubber bands needed is _____."
4. Test your prediction and analyze the outcome. Determine whether the prediction matched reality, how far off the prediction was, and what errors or issues arose that may have thrown off the results of your simulation. Test and analyze three more predictions.
5. Analyze the maximum errors found in your tests. Then find out the height of your favorite location (such as the Statue of Liberty, Eiffel Tower, or Golden Gate Bridge). If you drop your action figure from the top of that location, how many rubber bands would you need for a safe drop from that height? What would you expect to be the maximum error in your prediction?
6. Now, consider the realities of bungee jumping with real human beings using real bungee cords and equipment. Discuss the following with your mentor:
   A. The factors that need to be considered when testing this equipment to develop safety protocols
   B. Reliable statistics on the risk of serious injury or death while bungee jumping
   C. Bungee jumping is one of the high-adventure activities that is expressly not allowed by the Boy Scouts of America. What do you think of this policy?
7. Create a report addressed to the Risk Management Board of the Acme Daredevil Adventure Company. In your report, include the following:
   A. A description of your simulation
   B. Your simulation data displayed in a chart and graph
   C. How your data led to your ability to make predictions about safe bungee jumping heights
   D. The variables that might have affected your predictions

   Share your report with your mentor.

Source: The ideas for this activity are based on multiple versions of an activity available online titled Bungee Barbie and Kamikaze Ken. The originator of idea for this activity is unknown.

Linking the Past to the Future: Predicting Old Faithful's Next Eruption

This activity can be done individually, but works much better with three to six people.

The scenario: You have lined up a summer job as a junior park ranger at Yellowstone National Park, where you know many visitors come to see the geyser Old Faithful. Many visitors arrive just after Old Faithful has erupted and they typically ask a nearby ranger when it is next expected to erupt. Your task is to analyze past data on Old Faithful's eruptions in order to devise a strategy for predicting the next eruption.

Part 1: Data Gathering and Initial Analysis

1. Gather information about geysers in general and their behavior.
   A. Find data on intervals (length of time) between eruptions for Old Faithful. Be aware that Old Faithful's eruption behavior has changed over the years. Use the most current data you can find. For your analysis and to test your prediction strategy, you will need information on all of the intervals for three consecutive 24-hour periods, plus intervals for the fourth consecutive 24-hour period. Each additional youth must use intervals for different days.
   B. Create two graphical displays of the data from three days of eruptions, analyze the patterns, and formulate your initial prediction strategy.

Part 2: Further Analysis, Refinement of Prediction Strategy, and Report

1. Do the following:
   A. Using the data you have collected for part 1, determine how much variability you see from day to day. How much variability is there within a single 24-hour period? Is knowledge of one interval sufficient to predict the next eruption? Why or why not?
   B. Determine what patterns in the data are illuminated (or perhaps obscured) in the different graphical displays. Of the graphs you used, which one best illustrated the wait time pattern for Old Faithful? Would you refine your prediction strategy? If so, why and how? If not, why not?
   C. Use your prediction strategy to estimate all of the eruptions for the fourth 24-hour period, and compare your estimates to the actual eruption times. Calculate the differences between your estimates and the actual times. What is the maximum difference? Why are there patterns in the Old Faithful data? Is there a geological explanation?
   D. Create a report that describes and addresses your prediction strategy, includes your graphical displays, and explains how your graphical displays support your strategy.
   E. Discuss the data you have collected, your report, and what you have learned with your mentor.

Resources

T. Scott Bryan. *Geysers: What They Are and How They Work*, 2nd ed. Mountain Press Publishing Company, 2005.

William J. Fritz. *Roadside Geology of the Yellowstone Country.* Mountain Press Publishing Company, 1985.

For more data, visit the Geyser Observation and Study Association at www.geyserstudy.org.

A Paradox of Counting: Voting Methods and Fair Decisions

This activity can be done individually or with a group of two to six people, and requires cooperation from about 20 to 30 individuals.

The scenario: Your unit wants to plan a superactivity for next summer but cannot agree on what that activity should be. There are four options under consideration, and your unit decides to vote. Your task is to collect ballots and tabulate results using several different voting methods.

This is not a binding decision on your unit! This is an exercise, but one that will be more meaningful if you use real-life possibilities.

Part 1: Ballot Setup, Gathering, and Tabulating

1. Decide on four superactivities that your unit would genuinely be interested in doing next summer. Aim for four genuine options, none of which is likely to receive a majority of the votes. Discuss these options with your mentor before doing the following:
   A. Create ballots on which each voter can list his/her first, second, third, and fourth choices from among the four prospective superactivities.
   B. Find 20 to 30 unit members, prospective guests for the superactivity, unit leaders, parents, and so on, to complete one ballot each. Each voter should vote sincerely, without trying to strategize.
   C. Do some research and learn how to tabulate winners using each of the following four voting methods:
      (1) Plurality method
      (2) Borda count method
      (3) Plurality-with-elimination method (sometimes called the instant runoff method)
      (4) Pair-wise comparison method (sometimes called Copeland's method)

Part 2: Analysis and Report

1. As you tabulate the results using each voting method, evaluate each method and discuss the following with your mentor.
   A. What do you notice? How *fair* is each method?
   B. How would the results be affected if two or three voters had cast strategic ballots (instead of sincere ballots), in an effort to "not waste their votes"?
   C. Which of the four voting methods do you believe is the right voting method for this decision in your unit? Why?
   D. Consider how we elect the president of the United States of America.
      (1) What voting method do we use?
      (2) What are its advantages and disadvantages?
      (3) Do you believe each voting citizen in the United States has an equal say in the vote tabulation?
      (4) Is it possible for citizens to cast strategic votes and influence the outcome of a presidential election?
2. Create a report that summarizes the results from the various voting methods, outlines your analysis, and comments on voting methods for the U.S. presidency. Share your report with your mentor.

Resources

Donald G. Saari. *Chaotic Elections! A Mathematician Looks at Voting* (for youth with stronger mathematics backgrounds). American Mathematical Society, 2001.

William Poundstone. *Gaming the Vote: Why Elections Aren't Fair (and What We Can Do About It)*. Hill and Wang, 2008.

A Guide for Nova Award Counselors and Supernova Award Mentors

Thank you for serving our youth as they embark on an exploration of science, technology, engineering, and mathematics, or STEM. Your role is crucial to their success in completing the Nova and Supernova activities and in discovering that science is fun and worth the effort, and the awards are attainable. This application of Lord Baden-Powell's "Fun With a Purpose" will inspire a new passion for STEM fields that will impact their lives—and yours—for years to come.

The Importance of STEM

Many professionals in science, technology, engineering, and mathematics believe the United States should do more to encourage students to enter these fields. It's our best opportunity to boost the spirit of innovation. It's what we need to help ensure this country continues on a prosperous and secure journey.

In the past few years, studies have shown U.S. students are growing increasingly weaker in STEM-related topics*. We can all work to help reverse this trend.

- In 2009, just 34 percent of U.S. eighth-graders were rated proficient or higher in a national math assessment; more than 25 percent scored below average.
- In an international exam given in 2006, U.S. high school students ranked 21st out of 30 industrialized nations in science and 25th in math.
- In 2010, only 43 percent of U.S. high school graduates were ready for college work in math and 29 percent were ready in science.

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 a basic understanding of math and science.

Ten-year employment projections by the U.S. Department of Labor show that of the 20 fastest-growing occupations projected for 2014, 15 of them require significant mathematics or science preparation.

Sources: National Academy of Sciences, National Academy of Engineering; ACT Inc.; National Center for Education Statistics

What Is Nova?

The Nova awards are designed to enhance interest in the STEM fields while making it fun for youth to learn about these fields. Scouting and the Nova awards nurture and help develop the natural curiosity of children and encourage their sense of wonder. The activities and requirements were designed keep youth interested and show relevance with society. Through field testing with hundreds of units and thousands of youth members, we have developed a program to enhance the Scouting experience and grow the Scout.

The Nova awards allow Scouts to discover some of the basic principles of STEM and experience science, technology, engineering, and math in fun and interesting ways. You will see how the activities excite and encourage a sense of wonder in youth. They can't help but enjoy themselves, and their enthusiasm will rub off on you, too. Scouts may complete any Nova award with a parent or unit leader's guidance.

The Supernova awards challenge Scouting youth who have a greater interest in the STEM fields to experiment, understand the outcomes of these experiments, and present their findings to their Supernova mentor. Just like merit badge counselors, mentors must be registered with the BSA as an adult volunteer and be approved by the local council.

Use this counselor section to help youth and parents understand the STEM modules that are available.

The Nova Awards program helps youth to be "Prepared. For Life."

The series of Nova awards integrates many existing advancements from the Scouting program.

A website to support the BSA's Nova Awards program is available at www.scouting.org/stem. The site will be periodically updated.

Successful counselors and mentors will work hard to help youth meet the Nova and Supernova requirements. They will foster in young people a lifelong curiosity about science and understanding of how STEM fields affect just about every aspect of their lives. Why is this so important? Because science encourages students to ask questions and make connections as to how the world works. Strength in STEM fields gives them a deeper understanding of our world, a greater appreciation of its beauty and complexity, and the ability to solve problems necessary for a secure future.

Steppingstones to the Supernova Awards

Our goal is to entice our Scouts to begin exploring STEM topics and to build on their interest with progressively more challenging activities. The Nova Awards program has two distinct difficulty levels.

1. STEM-related activities and Nova awards are designed to be fun. The outcome of the Nova awards should focus on encouraging future exploration in STEM fields. We want to build confidence and communicate that career opportunities in STEM fields are attainable, fulfilling, and interesting. As such, Nova activities are fairly basic and designed to spark interest in one or all of the categories of awards. They are straightforward to complete and have a quick "reward" of the Nova patch for the first category earned and a pi (π) pin to attach to the Nova patch for each additional category earned. The Nova award in each category can be accomplished fairly easily in a few weeks.
2. Supernova activities and awards require a deeper level of understanding and effort. While Supernova awards are designed to be more difficult than the Nova awards, the focus is to build on the simple STEM topics with activities that will result in greater learning and an increasing complexity in the youth's knowledge. Completing the requirements takes more work and includes some research. Most Supernova activities will take several weeks or months to complete.

   Both Nova and Supernova requirements build on advance-ment from the Cub Scout and Boy Scout programs (STEM-related belt loops, pins, activity badges, and merit badges). The Boy Scout and Venturer Nova and Supernova requirements share some similarities, although requirements have been modified for Venturing.

Adult Roles: Nova Counselor and Supernova Mentor

The Nova Awards program is fairly simple as stated above, and more along the lines of completing an activity pin or merit badge. We use the word "counselor" for the adult working with the Nova candidates. Parents and unit leaders may serve as Nova counselors even if they have little or no background in STEM (although of course they do need to understand the material well enough to help the youth with questions).

Because the Supernova program is more complex, it will require a deeper and longer-term association between the adult and youth. As such, we designate the adult role as "mentor" to signify the relationship between adult and youth. A "mentor" is ideally someone who has successfully negotiated a STEM career path or has other subject matter expertise (such as hobbies or other special training), and is willing to share accumulated wisdom and experience. The adult will work closely with the youth for a number of weeks or months, and will likely provide significant input and guidance to Supernova candidates.

Youth Protection Guidelines

Like merit badge counselors, all Nova counselors and Supernova mentors must be registered with the Boy Scouts of America (unless you are working only with your own child) and must have current Youth Protection training and certification. Meetings must follow Youth Protection guidelines, with at least two Scouts or adults present at any meetings.

A Word About Youth Protection

Child abuse is a serious problem in our society, and unfortunately, it can occur anywhere, even in Scouting. Youth safety is of paramount importance to Scouting. For that reason, the BSA continues to create barriers to abuse beyond what have previously existed in Scouting.

The Boy Scouts of America places the greatest importance on providing the most secure environment possible for our youth members. To maintain such an environment, the BSA has developed numerous procedural and leadership selection policies, and provides parents and leaders with numerous online and print resources for the Cub Scout, Boy Scout, and Venturing programs.

The BSA requires Youth Protection training for all registered leaders.

New leaders are required to complete Youth Protection training. To take the training online, go to www.MyScouting.org and establish an account using the member number you receive when you register for BSA membership. If you take the training online before you obtain a member number, be sure to return to MyScouting and enter your number for training record credit. Your BSA local council also provides training on a regular basis if you cannot take it online. For more information, refer to the back of the BSA adult membership application, No. 524-501.

Youth Protection training must be taken every two years—regardless of position. If a volunteer does not meet the BSA's Youth Protection training requirement at the time of recharter, the volunteer will not be reregistered.

We encourage all adults, including all parents, to take the BSA's Youth Protection training.

To find out more about the Youth Protection policies of the Boy Scouts of America and how to help Scouting keep your family safe, see the *Parent's Guide* in any of the Cub Scouting or Boy Scouting handbooks, or go to http://www.scouting.org/Training/YouthProtection.aspx.

Revised October 2011

Age-Appropriate Expectations

Young people undergo profound developmental changes as they grow, including progression in their ability to think and reason. It is critical that you understand this and that you do not expect behaviors and outcomes that exceed their developmental readiness. At the same time, don't underestimate their abilities or make things too easy!

The goal is to encourage youth to stretch and grow, yet not frustrate them or turn them off to STEM activities by making it too challenging. Although this has been addressed within the scope of the requirements for each age group, you will be the one assessing your youth's readiness. Remember—Nova activities are supposed to be fun and an introduction, whereas Supernova activities will require more effort and perseverance, as well as critical thinking.

Each award is available to a wide range of youth members—from ages 8 to 10 for Cub Scouts, 11 to 17 for Boy Scouts, and 14 through 20 (or age 13 with the completion of the eighth grade) for Venturers. It is important that you understand the developmental differences between various ages. The awards have been designed to take this into account. It is very unlikely that a 12-year-old Boy Scout or a 14-year-old Venturer will feel ready to earn the Supernova award. You should be aware of age-related capabilities, as well as recognize that academic and extracurricular backgrounds will also differ.

Critical thinking goes beyond just coming up with an answer. It is the "identification and evaluation of evidence to guide decision making. A critical thinker uses broad in-depth analysis of evidence to make decisions and communicate his/her beliefs clearly and accurately." Source: The Critical Thinking Co.™

How do you know what is expected at any given age? There can be a very broad range of abilities and knowledge among youths of the same age. Some of this may depend on where they live, their school system, or their socioeconomic background. A useful link to age-specific benchmarks may be found at www.project2061.org/publications/bsl/online. The information presented here may alert you to something you might not have known about the way youth reason.

The potential for a young person to learn and do is continuous and gradual, and young people may aspire to develop the skills necessary to earn the Nova and Supernova awards. The best advice is to know the youth you are working with.

Counseling and Mentoring Sessions

There is no set number of required counseling or mentoring sessions, although a preliminary meeting with the youth is a good idea for setting expectations and answering questions. There is also no time limit for completion (other than aging out of a specific program). You and the Scout will determine the time frame for completing the award.

After completing the requirements, Venturers will complete their Supernova application. (The Nova awards do not require an application.) Please help ensure that the youth is properly recognized in a timely manner, as we do with all advancement and awards in Scouting.

Group Size

You may work with only one youth, or you may assist a group of youth members. It is imperative that EACH youth do ALL of the work for each requirement. This can be a challenge to monitor if the group is too large. We recommend no more than a patrol-size group (maximum of eight to 10). Of course you may mentor more youths than this—just don't have them all present at the same time, so that each individual gets the full benefit of your attention.

Expected Outcomes

With your help, each youth who attempts to earn the Nova and Supernova awards will emerge with a basic understanding of the material in the requirements. This may be an introduction to a field that the youth would never otherwise be exposed to, or may be a deeper exploration of fields in which the youth already has an interest. He or she will see how these relate to everyday life and how STEM fields are everywhere. We expect to see greater confidence and the excitement to tackle subjects that were once intimidating. With your help, our youth will be equipped to tackle new challenges in STEM-related fields.

Nova/Supernova Requirements

We have provided some specifics to the "answers" for some of the Nova requirements to help you in your role as counselor or mentor. However, these are by no means complete. We encourage you to use whatever resources you have available to expand your—and your youth's—thinking, knowledge, and enthusiasm for STEM fields.

An online resource for the Nova and Supernova Awards program is available at www.scouting.org/stem. It includes Frequently Asked Questions, new activities, ideas, and more. Be sure to check this resource, as materials will be regularly updated and enhanced.

Launch!

This module is designed to help the Venturer explore how science affects his or her life each day.

1. Choose A *or* B *or* C and complete ALL the requirements.
   A. Watch about three hours total of science-related shows or documentaries that involve projectiles, aviation, weather, astronomy, or space technology. Then do the following:
      (1) Make a list of at least two questions or ideas from each show.
      (2) Discuss two of the questions or ideas with your counselor.

Some examples include—but are not limited to—shows found on PBS ("NOVA"), Discovery Channel, Science Channel, National Geographic Channel, TED Talks (online videos), and the History Channel. The NASA website at www.nasa.gov has some short multimedia clips that involve projectiles, aviation, space, weather, astronomy, or aviation or space technology. You may choose to watch a live performance or movie at a planetarium or science museum instead of watching a media production. You may watch online productions with your counselor's approval and under your parent's supervision.

   B. Read (about three hours total) about projectiles, aviation, space, weather, astronomy, or aviation or space technology. Then do the following:
      (1) Make a list of at least two questions or ideas from each article.
      (2) Discuss two of the questions or ideas with your counselor.

Examples of magazines include—but are not limited to—*Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover, Air & Space, Popular Astronomy, Astronomy, Science News, Sky & Telescope, Natural History, Robot, Servo, Nuts and Volts,* and *Scientific American.*

   C. Do a combination of reading and watching (about three hours total). Then do the following:
      (1) Make a list of at least two questions or ideas from each article or show.
      (2) Discuss two of the questions or ideas with your counselor.

2. Choose ONE STEM field of interest from the following list. Complete ALL the requirements for a Venturing STEM exploration in that field. See pages 27–29 for the requirements. (If you have already completed a Venturing STEM exploration in one of these fields, please choose a different field for this award.)

Archery	Aviation	Shotgun Shooting
Astronomy	Rifle Shooting	Space Exploration
Athletics	Robotics	Weather

3. Choose A *or* B and complete ALL the requirements.

A. Simulations. Find and use a projectile simulation applet on the Internet (with your parent's or guardian's permission). Then design and complete a hands-on experiment to demonstrate projectile motion.

(1) Keep a record of the angle, time, and distance.

(2) Graph the results of your experiment. (Note: Using a high-speed camera or video camera may make the graphing easier, as will doing many repetitions using variable heights from which the projectile can be launched.)

Helpful Links

Be sure you have your parent's or guardian's permission before using the Internet. Some of these websites require the use of Java runtime environments. If your computer does not support this program, you may not be able to visit those sites.

Projectile Motion Applets
Website: http://www.mhhe.com/physsci/physical/giambattista/proj/projectile.html

Fowler's Physics Applets
Website: http://galileoandeinstein.physics.virginia.edu/more_stuff/Applets/ProjectileMotion/enapplet.html

Java Applets on Physics
Website: http://www.walter-fendt.de/ph14e/projectile.htm

(3) Discuss with your counselor:

(a) What a projectile is

A projectile is:

- An object that is fired, launched, or thrown, but which cannot propel itself
- A self-propelled missile, like a rocket

(b) What projectile motion is

(c) The factors affecting the path of a projectile

When an object is fired, launched, or thrown, it is given horizontal velocity. (Velocity is the same as speed, but it is speed in a given direction.) Once the object is launched, no additional force providing horizontal velocity is applied. Newton's First Law of Motion states that a body at rest stays at rest and a body in motion stays in motion unless acted upon by an outside force. If gravity did not act on the projectile's path, the object would continue to move in the direction in which it was launched.

Once the object has been launched, the only force acting upon it is the force of gravity, which accelerates the object toward Earth.

Projectile motion is the curved path taken by an object that is fired, launched, or thrown. See www.ncsec.org/cadre2/team1_2/pm.htm.

Helpful Links

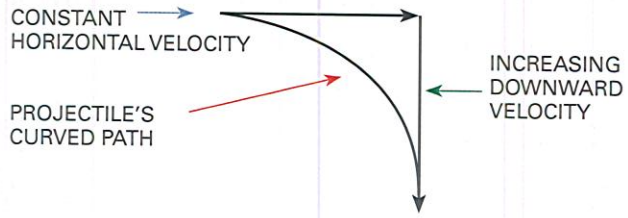
"New York State High School Regents Exam Prep: Physics": New York State High School Regents Exam Prep Center
Website: http://www.regentsprep.org/Regents/physics/phys-topic.cfm?Course=PHYS&TopicCode=01a

"Free Fall and the Acceleration of Gravity": The Physics Classroom
Website: http://www.physicsclassroom.com/class/1dkin/u1l5b.cfm

"Vectors—Fundamentals and Operations": The Physics Classroom
Website: http://www.physicsclassroom.com/class/vectors/u3l1e.cfm#trig

"Projectile Motion": The Physics Classroom
Website: http://www.physicsclassroom.com/class/vectors/u3l2a.cfm

Projectile motion is caused by the force of gravity giving vertical acceleration to an object that has horizontal velocity. (When an object is thrown straight up in the air, the force of gravity slows it down, it comes momentarily to a complete stop, then it accelerates downward.) An object that has been launched will continue to move in the direction it was thrown at the speed with which it was thrown, except for being slowed down by friction with the air (air resistance), but it will begin to accelerate toward Earth, moving faster toward Earth all the time. The combination of constant horizontal velocity and increasing downward velocity due to the acceleration of gravity is what gives a projectile its curved path.



(d) The difference between forward velocity and acceleration due to gravity

Forward velocity is the speed horizontal to Earth given to a projectile. If the projectile is thrown parallel to Earth, all of its original speed will be its forward velocity. If an object is thrown at an angle to Earth, the forward velocity is that portion of the velocity that is parallel to Earth. (Determining forward velocity can be done by separating the velocity into horizontal and vertical components—like on a triangle—using vector resolution.)

Forward velocity has a constant speed.

Acceleration due to gravity slows down things that are moving upward and speeds up things that are moving downward. At most locations on Earth, the acceleration of gravity (9.80 m/s^2, or ~32.174 ft/s^2) will cause an object to fall 9.8 meters per second faster each second. An object starting with no vertical motion will be falling toward Earth at the rate of 9.8 m/s at the end of one second and at the rate of 19.6 m/s at the end of two seconds. Acceleration due to gravity is constantly changing the vertical speed/velocity of an object.

B. Discover. Explain to your counselor the difference between escape velocity (not the game), orbital velocity, and terminal velocity. Then answer TWO of the following questions. (With your parent's or guardian's permission, you may wish to explore websites to find this information.)

(1) Why are satellites usually launched toward the east, and what is a launch window?

Escape velocity is the speed at which an object will be able to escape the gravity of Earth, the moon, or other body. An object must travel fast enough that it will not fall back to the surface. Escape velocity from Earth is 11.2 km/s, or 25038.72 mph. Escape velocity is proportional to the square root of the ratio between the mass of the larger body and the distance of the smaller object from the center of the larger body.

Helpful Links

"Escape Velocity": Georgia State University
Website: http://hyperphysics.phy-astr.gsu.edu/hbase/vesc.html

"Space Environment": Northwestern University
Website: http://www.qrg.northwestern.edu/projects/vss/docs/space-environment/2-whats-escape-velocity.html

Orbital velocity is achieved when an object's horizontal velocity balances the acceleration of gravity at that location in space. An object that has orbital velocity (is in orbit) continues to fall toward Earth as it travels away from Earth, giving the object a circular path around Earth. The object continually falls around Earth due to the combination of horizontal velocity and acceleration due to gravity.

Terminal velocity is the point at which the acceleration of gravity on an object matches the air resistance of the object. Terminal velocity is affected by the weight of the object and its orientation. (The more surface area that is horizontal to Earth, the lower the terminal velocity. Skydivers who perform aerial displays use this fact. The first divers to jump lie flat to increase their air resistance. Later divers streamline dive by holding their arms and legs tightly to their bodies and dive headfirst toward Earth in order to catch the earlier divers in the air.)

Note: If it were not for air resistance, all objects, regardless of mass, size, or any other factor, would fall at the SAME velocity.

Watch astronauts David Scott and Jim Irwin do Galileo's experiment on the moon.

"NASA Lunar Feather Drop Home Page": NASA
Website: http://er.jsc.nasa.gov/seh/feather.html

When satellites are launched to the east, Earth's spin effectively adds to their velocity, making escape velocity easier to obtain and requiring less fuel. Not all spacecraft are launched toward the east; the launch direction depends also on the final orbit and purpose of the satellite.

In order for a spacecraft to rendezvous with another spacecraft or other object in space, the orbits of both objects must be taken into consideration. A launch window describes a time period in which a mission must be launched for the objects' orbits to overlap.

(2) What is the average terminal velocity of a skydiver? (What is the fastest you would go if you were to jump out of an airplane?)

Terminal velocity is when the acceleration due to gravity is matched by the air resistance (or resistance of whatever fluid the object is traveling through). When the acceleration of gravity is balanced by air resistance, the object continues to fall, but it does not increase its velocity.

"A person has a terminal velocity of about 200 mph when balled up and about 125 mph with arms and feet fully extended to catch the wind."
Source: "Speed of a Skydiver (Terminal Velocity)," The Physics Factbook, website http://hypertextbook.com/facts/JianHuang.shtml.

(3) How fast does a bullet, baseball, airplane, or rocket have to travel in order to escape Earth's gravitational field? (What is Earth's escape velocity?)

Helpful Links

"Orbital Mechanics": Rocket & Space Technology
Website: http://www.braeunig.us/space/orbmech.htm

"Launching Satellites": EUMETSAT
Website: http://www.eumetsat.int/Home/Main/Satellites/SatelliteProgrammesOverview/SP_20100427133512861?l=en

"What is a 'launch window'?": ESA
Website: http://www.esa.int/esaSC/SEMO49YO4HD_index_0.html

"Launch Windows: How NASA Decides When to Fly": NRP
Website: http://www.npr.org/templates/story/story.php?storyId=4749663

"What Is a Launch Window?": NASA
Website: http://www.nasa.gov/audience/forstudents/brainbites/nonflash/bb_home_launchwindow.html

"Terminal Velocity": NASA
Website: http://exploration.grc.nasa.gov/education/rocket/termvr.html

4. Choose A *or* B and complete ALL the requirements.
   A. Visit an observatory or a flight, aviation, or space museum.
      (1) During your visit, talk to a docent or person in charge about a science topic related to the site.
      (2) Discuss your visit with your counselor.
   B. Discover the latitude and longitude coordinates of your current position.
      (1) Find out what time a satellite will pass over your area. (A good resource to find the times for satellite passes is the Heavens Above website at www.heavens-above.com.)
      (2) Watch the satellite using binoculars. Record the time of your viewing, the weather conditions, how long the satellite was visible, and the path of the satellite. Discuss your viewing with your counselor.
5. Choose A *or* B *or* C and complete ALL the requirements.
   A. Design and build a catapult that will launch a marshmallow a distance of 4 feet. Then do the following:
      (1) Keep track of your experimental data for every attempt. Include the angle of launch and the distance projected.

Escape velocity from Earth is 11.2 km/s, or 25038.72 mph.

(2) Make sure you apply the same force every time, perhaps by using a weight to launch the marshmallow.

Discuss your design, data, and experiments—both successes and failures—with your counselor.

B. Design a pitching machine that will lob a softball into the strike zone. Answer the following questions, then discuss your design, data, and experiments—both successes and failures—with your counselor.

(1) At what angle and velocity will your machine need to eject the softball in order for the ball to travel through the strike zone from the pitcher's mound?

(2) How much force will you need to apply in order to power the ball to the plate?

(3) If you were to use a power supply for your machine, what power source would you choose and why?

C. Design and build a marble run or roller coaster that includes an empty space where the marble has to jump from one part of the chute to the other. Do the following, then discuss your design, data, and experiments—both successes and failures—with your counselor.

(1) Keep track of your experimental data for every attempt. Include the vertical angle between the two parts of the chute and the horizontal distance between the two parts of the chute.

(2) Experiment with different starting heights for the marble. How do the starting heights affect the velocity of the marble? How does the starting height affect the jump distance?

6. Discuss with your counselor how science affects your everyday life.

Power Up

This module is designed to help Venturers explore how technology affects their life each day.

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

A. Watch about three hours total of technology-related shows or documentaries that involve transportation or transportation technology. Then do the following:

(1) Make a list of at least two questions or ideas from each show.

(2) Discuss two of the questions or ideas with your counselor.

Some examples include—but are not limited to—shows found on PBS ("NOVA"), Discovery Channel, Science Channel, National Geographic Channel, TED Talks (online videos), and the History Channel. You may choose to watch a live performance or movie at a planetarium or science museum instead of watching a media production. You may watch online productions with your counselor's approval and under your parent's supervision.

B. Read (about three hours total) about transportation or transportation technology. Then do the following:

(1) Make a list of at least two questions or ideas from each article.

(2) Discuss two of the questions or ideas with your counselor.

Examples of magazines include—but are not limited to—*Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover, Air & Space, Popular Astronomy, Astronomy, Science News, Sky & Telescope, Natural History, Robot, Servo, Nuts and Volts,* and *Scientific American.*

C. Do a combination of reading and watching (about three hours total). Then do the following:

(1) Make a list of at least two questions or ideas from each article or show.

(2) Discuss two of the questions or ideas with your counselor.

2. Choose ONE STEM field of interest from the following list. Complete ALL the requirements for a Venturing STEM exploration in that field. See pages 27–29 for the requirements. (If you have already completed a Venturing STEM exploration in one of these fields, please choose a different field for this award.)

Automotive Maintenance	Electricity	Railroading
Aviation	Energy	Small-Boat Sailing
Canoeing	Farm Mechanics	Space Exploration
Cycling	Motorboating	Truck Transportation
Drafting	Nuclear Science	

3. Do ALL of the following.

A. Using the requirements from the above list of STEM explorations:

(1) Tell your counselor the energy source(s) used in these STEM explorations.

Automotive Maintenance—Gasoline, diesel fuel, electric, blended gasoline, biodiesel, hybrid

Aviation—Aviation fuel and kerosene

Canoeing—Human power

Cycling—Human power

Drafting—Human power, electricity

Electricity—Electromagnetism, chemical

Energy—Biomass digesters, cogeneration, fossil fuel power, fuel cells, geothermal power, nuclear power, solar power, tidal energy, wave energy, ocean thermal energy, wind

Farm Mechanics—Diesel fuel

Motorboating—Gasoline, diesel fuel, blended gasoline, biodiesel

Nuclear Science—Nuclear energy

Railroading—Diesel fuel

Small-Boat Sailing—Wind

Space Exploration—Most common solid: ammonium perchlorate mixed with powdered aluminum

Liquids for first-stage rockets—RP-1

Liquids for second-stage rockets—Liquid hydrogen, liquid oxygen

Truck Transportation—Diesel fuel

(2) Discuss the pros and cons of each energy source with your counselor.

Helpful Links

The following links are places to start when researching the pros and cons of fuel types. It is not an exhaustive list.

"Diesel Fuel vs. Unleaded Gasoline": CarsDirect.com
Website: http://www.carsdirect.com/car-buying/diesel-fuel-vs-unleaded-gasoline-understand-the-pros-and-cons

"Diesel Reborn": Edmunds.com
Website: http://www.edmunds.com/fuel-economy/diesel-reborn.html

"Electric Cars vs. Gasoline Cars and Other Vehicles": CarsDirect.com
Website: http://www.carsdirect.com/green-cars/electric-cars-vs-gasoline-cars-get-the-facts

"Aviation Fuel": U.S. Centennial of Flight Commission
Website: http://www.centennialofflight.gov/essay/Evolution_of_Technology/fuel/Tech21.htm

"Aviation Jet Fuel Information": CSGNetwork.com
Website: http://www.csgnetwork.com/jetfuel.html

"Today's Marine Fuel Choices": Boating & Sailing @ Suite 101
Website: http://www.suite101.com/content/todays-marine-fuel-choices-a27218

"What kind of fuel do rockets use and how does it give them enough power to get into space?": Scientific American
Website http://www.scientificamerican.com/article.cfm?id=what-kind-of-fuel-do-rock

B. Make a list of sources of energy that may be possible to use in transportation. (See the list earlier in this section.)

C. With your counselor:
   (1) Discuss alternative sources of energy.
   (2) Discuss the pros and cons of using alternative energy sources.

Helpful Links

The following links are places to start when researching alternative fuels. It is not an exhaustive list. You can also search "Air Force alternative fuels" using your favorite search engine. Be sure you have your parent's or guardian's permission to use the Internet.

"A Student's Guide to Alternative Fuel Vehicles:" California Energy Commission
Website: http://www.energyquest.ca.gov/transportation/index.html

"Ethanol? Fuel Cell? Biodiesel? An Alternative Fuels Overview": Edmunds.com
Website: http://www.edmunds.com/fuel-economy/ethanol-fuel-cell-biodiesel-an-alternative-fuel-overview.html?articleid=110054&

"Alternative & Advanced Vehicles": U.S. Department of Energy
Website: http://www.afdc.energy.gov/afdc/vehicles/electric_benefits.html

"Alternative Fuels": U.S. Department of Energy
Website: http://www.fueleconomy.gov/feg/current.shtml

"Alternative Fuel": Popular Mechanics
Website: http://www.popularmechanics.com/cars/alternative-fuel

"NASA: alternative fuels for aviation": Post Carbon Institute
Website: http://www.energybulletin.net/node/23098

"Nuclear Power and the Environment": U.S. Energy Information Administration
Website: http://www.eia.gov/energyexplained/index.cfm?page=nuclear_environment

"An Introduction to Solar Energy": Eric W. Brown, Northeastern University
Website: http://www.ccs.neu.edu/home/feneric/solar.html

"How Solar Panels Could Power 90% of US Transportation": Gas 2.0
Website: http://gas2.org/2008/03/25/how-solar-panels-could-power-90-of-us-transportation

"Nuclear Power: A Leading Strategy to Reduce Oil Imports": American Nuclear Society
Website: http://www.ans.org/pi/ps/docs/ps82.pdf

"Wind Power for Cars": Wind Power Authority
Website: http://windpowerauthority.com/wind-power-for-cars

"Denmark to power electric cars by wind in vehicle-to-grid experiment": The Guardian
Website: http://www.guardian.co.uk/environment/2009/jun/19/denmark-wind-electric-cars

4. Design and build a working model vehicle (not from a kit).
   A. Make drawings and specifications of your model vehicle before you begin to build.
   B. Include one of the following energy sources to power your vehicle (do not use gasoline or other combustible fuel source): solar power, wind power, or battery power.
   C. Test your model. Then answer the following questions:
      (1) How well did it perform?
      (2) Did it move as well as you thought it would?
      (3) Did you encounter problems? How can these problems be corrected?
   D. Discuss with your counselor:
      (1) Any difficulties you encountered in designing and building your model
      (2) Why you chose a particular energy source
      (3) Whether your model met your specifications
      (4) How you would modify your design to make it better
5. Discuss with your counselor how technology affects your everyday life.

Hang On!

This module is designed to help Venturers explore how engineering affects their life each day.

1. Choose A *or* B *or* C and complete ALL the requirements.
   A. Watch about three hours total of engineering-related shows or documentaries that involve motion or motion-inspired technology. Then do the following:
      (1) Make a list of at least two questions or ideas from each show.
      (2) Discuss two of the questions or ideas with your counselor.

Some examples include—but are not limited to—shows found on PBS ("NOVA"), Discovery Channel, Science Channel, National Geographic Channel, TED Talks (online videos), and the History Channel. You may choose to watch a live performance or movie at a planetarium or science museum instead of watching a media production. You may watch online productions with your counselor's approval and under your parent's supervision. One example is the NOVA Lever an Obelisk page on ancient Egypt and the use of levers, available at http://www.pbs.org/wgbh/nova/egypt/raising/lever.html.

B. Read (about three hours total) about motion or motion-inspired technology. Then do the following:
   (1) Make a list of at least two questions or ideas from each article.
   (2) Discuss two of the questions or ideas with your counselor.

Examples of magazines include—but are not limited to—*Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover, Air & Space, Popular Astronomy, Astronomy, Science News, Sky & Telescope, Natural History, Robot, Servo, Nuts and Volts,* and *Scientific American.*

C. Do a combination of reading and watching (about three hours total). Then do the following:
   (1) Make a list of at least two questions or ideas from each article or show.
   (2) Discuss two of the questions or ideas with your counselor.

2. Choose ONE STEM field of interest from the following list. Complete ALL the requirements for a Venturing STEM exploration in that field. See pages 27–29 for the requirements. (If you have already completed a Venturing STEM exploration in one of these fields, please choose a different field for this award.)

Archery	Electronics	Railroading
Aviation	Engineering	Rifle Shooting
Composite Materials	Inventing	Robotics
Drafting	Model Design and Building	Shotgun Shooting

Composites can be found just about everywhere: in airplanes and sports cars, golf clubs and guitars, boats and baseball bats, bathtubs and circuit boards, and even bridges. Composites make bicycles and skis lighter, kayaks and fishing poles stronger, houses warmer, and helmets tougher. Venturers can choose one of these items for their discussion to answer requirement 3c.

3. Do ALL of the following:
   A. Make a list or drawing of the six simple machines.

Helpful Links

"Simple Machine Elements": Connexions
Website: http://cnx.org/content/m13594/latest

"Resource Information for Teaching Simple Machines": Illinois State University Department of Physics
Website: http://www.phy.ilstu.edu/pte/489.01content/simple_machines/simple_machines.html

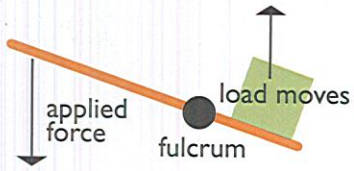
A lever is a rigid bar that turns around a fulcrum or fixed point. The force—a push or a pull that is applied to the lever—is called the effort. The farther the effort is from the fulcrum, the easier it is to use the lever. What the lever moves is called the load or the resistance. Levers can change the direction of motion, make it easier to move something, or cause something to move a greater distance. There are three classes, or types, of levers.

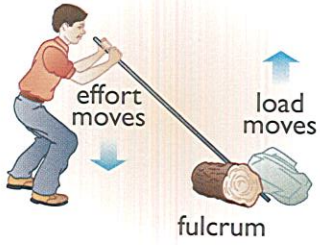
Class 1 lever—The fulcrum is located between the effort and the load. The direction the load moves is opposite the direction of the effort. Depending on where the fulcrum is placed, a class 1 lever can either move the load more easily or move the load a greater distance. Examples of class 1 levers include seesaws, crowbars, scissors, and pliers.

Class 2 lever—The fulcrum is at one end, the effort is at the other end, and the load is in the middle. The effort and the load move in the same direction. A class 2 lever makes an object easier to move. Examples of class 2 levers include catapults, screwdrivers, nutcrackers, staplers, and wheelbarrows.

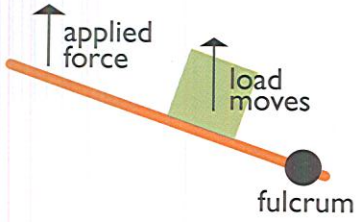
Class 3 lever—The fulcrum is at one end, and the effort is applied between the fulcrum and the load. The effort and the load move in the same direction. A class 3 lever makes an object harder to move but moves the object a much greater distance than the effort moves. Because the load end moves faster than the effort (it has to travel farther during the same amount of time), the load gains speed. Many sporting activities use class 3 levers. Examples of class 3 levers include bats, rackets, paddles, clubs, fishing poles, and brooms.

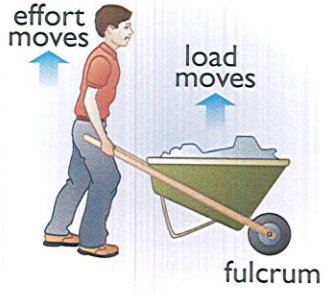
CLASS 1 LEVER



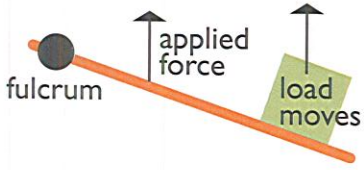


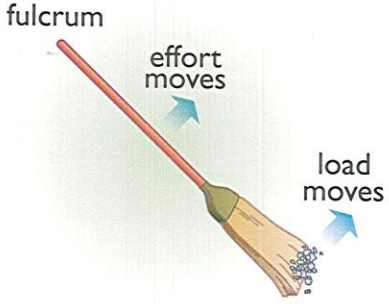
CLASS 2 LEVER

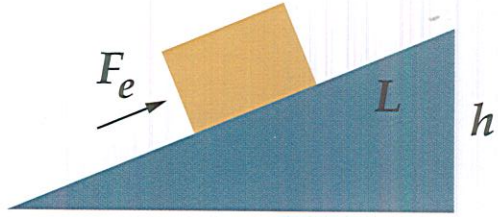




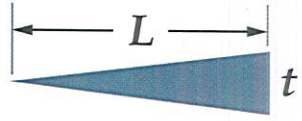
CLASS 3 LEVER



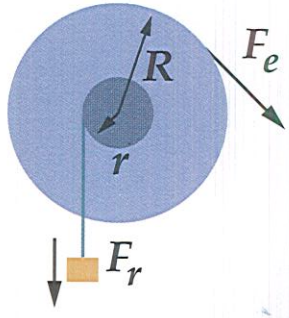




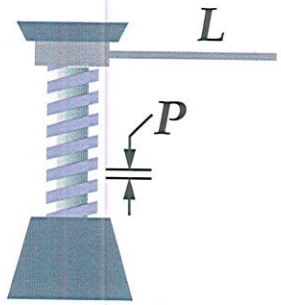
An inclined plane is a device such as a ramp, stair, or ladder and is used to more easily raise a load. The steepness of the incline affects the level of ease of movement. While a shallow incline makes it easier to raise a load, the length of the incline must be longer to compensate.



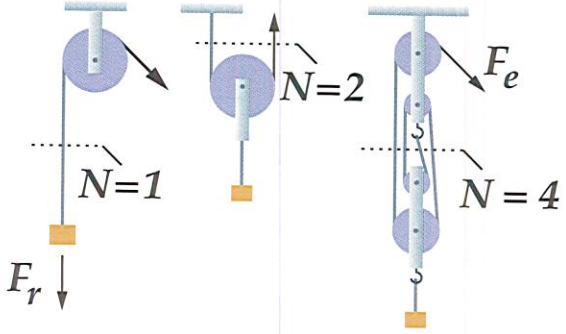
A wedge is a movable double incline plane used to separate objects by the use of force. Examples include a knife, ax, and nail.



A wheel and axle is essentially a modified lever, but it can move a load farther than a lever can. The center of the axle serves as a fulcrum. Gears, belts, cams, and cranks include applications of a wheel and axle.



A screw is an inclined plane wrapped in a spiral around a shaft.



A pulley is a wheel over which a rope or belt is passed. It is also a form of the wheel and axle. Pulleys are often interconnected in order to obtain considerable mechanical advantage. Pulleys may be used to change the direction of the force or to increase the ease of lifting an object.

B. Be able to tell your counselor the name of each machine and how each machine works.

C. Discuss the following with your counselor:

(1) The simple machines that were involved with the motion in your chosen STEM exploration (Hint: Look at the moving parts of an engine to find simple machines.)

Helpful Link

"Six Simple Machines": ConstructionKnowledge.net
Website: http://www.constructionknowledge.net/general_technical_knowledge/general_tech_basic_six_simple_machines.php

"Simple Machines": Harrisonburg City Public Schools
Website: http://staff.harrisonburg.k12.va.us/~mwampole/1-resources/simple-machines

Archery—The bow is a lever and the hand is the fulcrum. Crossbows use a pulley.

Aviation—Wheel and axle, levers, and pulleys. Propellers are a type of screw.

Composite Materials—Composites can be found just about everywhere: in airplanes, golf clubs, baseball bats, circuit boards, and even bridges. Composites make sporting equipment lighter and stronger, houses warmer, and helmets tougher. Pick a composite product and discuss the machines made of the components.

Drafting—Incline plane (triangle), wheel and axle, and lever.

Electronics—Varies. Lever used in soldering irons, switches, and circuit breakers (see http://electronics.howstuffworks.com/circuit-breaker2.htm).

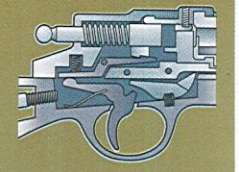
Engineering—Engineering makes use of all the simple machines. See http://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_simple/cub_simple_lesson01.xml.

Inventing—Inventors can use simple machines to help them construct their prototypes; their inventions may incorporate simple machines.

Model Design and Building—Tools such as knives (wedge), handsaws (wedge), vises (screw and lever), files, hammers (lever), screwdrivers (lever), hand drills (screw, wheel and axle), drill bits (screw), and pliers (two levers working together).

Railroading—Levers, wheel and axle.

Rifle Shooting—The fulcrum (pivot point) in the trigger mechanism is between the effort (applied by the trigger finger) and where the pressure (the load or resistance) is applied to the spring.



Robotics—Robot designers and builders can use simple machines to help them build their robots. Robots may contain simple machines to help them function, similar to how the human body incorporates simple machines.

Shotgun Shooting—See Rifle Shooting.

(2) The energy source causing the motion for the subject of your STEM exploration
(3) What you learned about motion from doing the STEM exploration

Wind, gasoline/fossil fuel, electric power, and human power all are sources of energy.

4. Choose A *or* B and complete ALL the requirements.
   A. Visit an amusement park. Then discuss the following with your counselor:
      (1) The simple machines present in at least two of the rides
      (2) The forces involved in the motion of any two rides

A force is a push or a pull. Many rides use the force of gravity to cause changes in up and down motion. Rides that go in a circle use centripetal force.

   B. Visit a playground. Then discuss the following with your counselor:
      (1) The simple machines present in the playground equipment
      (2) The forces involved in the motion of any two playground fixtures
5. Do the following:
   A. On your own, design one of the following and include a drawing or sketch: an amusement park ride OR a playground fixture OR a method of transportation.
   B. Discuss with your counselor:
      (1) The simple machines present in your design
      (2) The energy source powering the motion of your creation
6. Discuss with your counselor how engineering affects your everyday life.

Numbers Don't Lie

This module is designed to help the Venturer explore how math affects his or her life each day.

1. Choose A *or* B *or* C *or* D and complete ALL the requirements.
   A. Watch about three hours total of math-related shows or documentaries that involve scientific models and modeling, physics, sports equipment design, bridge building, or cryptography. Then do the following:
      (1) Make a list of at least two questions or ideas from each show.
      (2) Discuss two of the questions or ideas with your counselor.

Some examples include—but are not limited to—shows found on PBS ("NOVA"), Discovery Channel, Science Channel, National Geographic Channel, TED Talks (online videos), and the History Channel. You may choose to watch a live performance or movie at a planetarium or science museum instead of watching a media production. You may watch online productions with your counselor's approval and under your parent's supervision.

   B. Research (about three hours total) several websites (with your parent's or guardian's permission) that discuss and explain cryptography or the discoveries of people who worked extensively with cryptography. Then do the following:
      (1) List and record the URLs of the websites you visited and the major topics covered on the websites you visited. (You may use the copy and paste function—eliminate the words—if you include your sources.)
      (2) Discuss with your counselor how cryptography is used in the military and in everyday life and how a cryptographer uses mathematics.

Helpful Link

"The Mathematics of Cryptology": University of Massachusetts
Website: http://www.math.umass.edu/~gunnells/talks/crypt.pdf

   C. Read at least three articles (about three hours total) about physics, math, modeling, or cryptography. You may wish to read about how technology and engineering are changing sports equipment, how and why triangles are used in construction, bridge building, engineering, climate and/or weather models, how banks keep information secure, or about the stock market. Then do the following:
      (1) Make a list of at least two questions or ideas from each article.
      (2) Discuss two of the questions or ideas with your counselor.

Examples of magazines include—but are not limited to—*Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover, Air & Space, Popular Astronomy, Astronomy, Science News, Sky & Telescope, Natural History, Robot, Servo, Nuts and Volts,* and *Scientific American.*

   D. Do a combination of reading, watching, or researching (about three hours total). Then do the following:
      (1) Make a list of at least two questions or ideas from each article, website, or show.
      (2) Discuss two of the questions or questions with your counselor.

2. Choose ONE STEM field of interest from the following list. Complete ALL the requirements for a Venturing STEM exploration in that field. See pages 27–29 for the requirements. (If you have already completed a Venturing STEM exploration in one of these fields, please choose a different field for this award.) After completion, discuss with your counselor how the Venturing STEM exploration you completed uses mathematics.

American Business	Entrepreneurship	Radio
Chess	Orienteering	Surveying
Computers	Personal Management	Weather
Drafting		

3. Choose TWO from A *or* B *or* C *or* D *or* E and complete ALL the requirements. (Write down your data and calculations to support your explanation to your counselor. You may use a spreadsheet. Do not use someone else's data or calculations.)

   A. Calculate your horsepower when you run up a flight of stairs.

Helpful Links

"How to Calculate Your Horsepower": wikiHow
Website: http://www.wikihow.com/Calculate-Your-Horsepower

"Lab Power": haplosciences.net
Website: http://onlinephys.com/labpower1.html

1. Find out how much you weigh in kilograms and write it down. (Multiply your weight in pounds by 0.454 to get kilograms.)
2. Find a stair, ladder, or something similar (as long as it gets you upward).
3. Measure the height (not the length) of the stairs (or whatever you use) from the bottom to the ending point at the top and write it down. This can be done by multiplying the height of one stair by the number of stairs (it doesn't matter how long the stairs are.)
4. 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.
5. Calculate the Power (P) with this formula:

   mah/t (m x 9.80 x h)/t, where

   m = mass (your weight) in kilograms

   a = acceleration (9.80 m/sec^2 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.
6. Divide the number of watts by 745.6 w/hp to get the number in horsepower.

(1) How does your horsepower compare to the power of a horse?

Horsepower is a unit of power. One horsepower equals 33,000 foot-pounds of work per minute, or 745.6 watts. James Watt, who invented steam engines, based his unit of power on how much weight a real horse could pull from a coal mine in one minute. (See "What Is Horsepower" at www.web-cars.com/math/horsepower.html.)

(2) How does your horsepower compare to the horsepower of your favorite car?

Share your calculations with your counselor, and discuss what you learned about horsepower.

Most car information packets and many websites list the horsepower of cars.

B. Attend at least two track, cross-country, or swim meets.
   (1) For each meet, time at least three racers. (Time the same racers at each meet.)
   (2) Calculate the average speed of the racers you timed. (Make sure you write down your data and calculations.)
   (3) Compare the average speeds of your racers to each other, to the official time, and to their times at the two meets you attended.

   Share your calculations with your counselor, and discuss your conclusions about the racers' strengths and weaknesses.

Average speed = Distance/Time

C. Attend a soccer, baseball, softball, or basketball game. Choose two players and keep track of their efforts during the game. (Make sure you write down your data and calculations.) Calculate their statistics using the following as examples:
   (1) Soccer—Goals, assists, corner kicks, keeper saves, fouls, offsides
   (2) Baseball or softball—Batting average, runs batted in, fielding statistics, pitching statistics
   (3) Basketball—Points, baskets attempted, rebounds, steals, turnovers, and blocked shots

   Share your calculations with your counselor, and discuss your conclusions about the players' strengths and weaknesses.

Helpful Links

The following are some sites to suggest but that do not have to be used.

"SoccerXpert.com Soccer Stats": SoccerXpert.com
Website: http://www.soccerxpert.com/docs/GameStats.pdf

The Baseball Scorecard
Website: http://www.baseballscorecard.com/downloads.htm

"How to Take Statistics at a Basketball Game"
Website: eHowhttp://www.ehow.com/how_4451141_take-statistics-basketball-game.html

D. Attend a football game or watch one on TV. (This is a fun activity to do with a parent or friend!) Keep track of the efforts of your favorite team during the game. (Make sure you write down your data and calculations.) Calculate your team's statistics using the following as examples:
   (1) Kicks/punts
      (a) Kickoff—Kick return yards
      (b) Punt—Number, yards
      (c) Field goals—Attempted, percent completed, yards
      (d) Extra point—Attempted, percent completed
   (2) Offense
      (a) Number of first downs
      (b) Forward passes—Attempted, percent completed, total length of passes, longest pass, number and length of passes caught by each receiver, yardage gained by each receiver after catching a pass
      (c) Running plays—Number, yards gained or lost for each run, longest run from scrimmage line, total yards gained or lost, and number of touchdowns
   (3) Defense—Number of quarterback sacks, interceptions turnovers, safeties

   Share your calculations with your counselor, and discuss your conclusions about your team's strengths and weaknesses.

E. How starry are your nights? Participate in a star count to find out. This may be done alone but is more fun with a group. Afterward, share your results with your counselor.

Half of the world's people live in cities. Because of light pollution, many city dwellers have never been able to see dark skies clearly. Among the issues associated with light pollution are energy conservation, effects on wildlife, and the ability to clearly see the night sky. While light pollution is a concern on the global level, it is also something that can be easily addressed at the local level.

Helpful Links

Several web-based efforts exist to bring awareness to the diminishing night skies.

"Less of Our Light for More Star Light": GLOBE at Night
Website: http://www.globeatnight.org

"Windows to the Universe": National Earth Science Teachers Association
Website: http://www.windows2universe.org

International Dark-Sky Association
Website: http://www.darksky.org

"Seeing in the dark": Dark Skies Awareness
Website: http://www.darkskiesawareness.org

(1) Visit NASA's Student Observation Network website (with your parent's or guardian's permission) at www.nasa.gov/audience/foreducators/son/energy/starcount/ for instructions on performing a star count.
(2) Do a star count on five clear nights at the same time each night.
(3) Report your results on NASA's Student Observation Network website (with your parent's or guardian's permission) and see how your data compares to others.

There are several websites for participating in star counts, but NASA's website seems the most general and straightforward to use. (The others require specific nights for observations.) This website has nice step-by-step instructions for the star count and it provides a calculation sheet that simplifies the star count data (http://www.nasa.gov/pdf/145989main_StarCountDataSheet_v4a.pdf).

4. Do ALL of the following.
   A. Investigate your calculator and explore the different functions.
   B. Discuss the functions, abilities, and limitations of your calculator with your counselor. Talk about how these affect what you can and cannot do with a calculator. (See your counselor for some ideas to consider.)
5. Discuss with your counselor how math affects your everyday life.

Here are some ideas for your Venturer to consider. Pick a few or think of others.

- How can you add fractions using your calculator and get an answer in fraction form?
- How can you perform repeated calculations efficiently?
- How many digits in a numerical answer can your calculator display? What if the answer to your calculation has more digits than your calculator can display? Can you figure out how many digits your answer has? Can you figure out the hidden digits?
- How can you enter, store, recall, and use a list of data to perform data analysis calculations?
- For a calculator with graphing capabilities, how can you display a graph? Will a graphing calculator always show the entire graph or does it sometimes show only a portion of the graph? If it shows only a portion of the graph, how can you be certain that the portion you are viewing shows the features you want to see?
- For numerical calculations, when does your calculator give exact answers and when does it give approximate answers? What is the difference? How can you tell? Does it matter?
- If your calculator defaults to giving you an approximate answer, but you need an exact answer, what do you do?
- If an approximate answer will do, how might your calculator's internal calculation limitations affect the accuracy of the approximation?
- For a calculator with graphing capabilities, how might pixel limitations affect its depiction of a graph?
- Is the calculator always right? Why or why not? How might you tell? What might cause a calculator to give you an incorrect answer? (For a graphing calculator, what might cause the calculator to give you an incorrect graph, no graph, or a graph that cannot be readily interpreted?)
- Are there numerical calculations that calculators can't do? If possible, give an example.

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Hundreds of adults and youth members throughout the country participated in a pilot program through their local council and Cub Scout packs, Boy Scout troops, and Venturer crews. With their assistance, the BSA was able to develop an impactful and meaningful awards program for young people that will inspire them to explore science, technology, engineering, and mathematics in their day-to-day life, their studies, and career possibilities.