



What is Science?

1. What is Science?
 - a. Spend some time building your understanding of what the term *science* means. Find at least three different written responses to the question, “What is science?” (Perhaps you can find quotes by famous scientists, past or present, on this topic.) Interview at least three different people who have an interest in science, asking this same question of all three and following up with additional questions. (See suggestions for additional interview questions here.) Based on what you learned, prepare your own response to the question, “What is science?” and discuss with your NOVA counselor.
 - b. Find and study at least three sources of information (television show, book, magazine article, internet site) related to a particular topic within chemistry, physics, biology, astronomy, geology, or other area of science. (All sources must relate to the *same* topic. Social sciences are allowed as well.) Learn the material presented. Discuss what you learned with your NOVA counselor. Prepare and give a presentation to your crew or another group approved by your NOVA counselor on what you learned. (See below for presentation options). Document your presentation with a one-page summary that contains a picture and a 1-2 paragraph description. Presentation Options (Choose a different one for each NOVA award you complete.)

- i. Make an informal, oral presentation involving a tabletop display along with discussion of what you learned.
- ii. Make a formal, oral presentation of at least 20 minutes. Include demonstrations, visual aids, or other techniques that will help you communicate more effectively.
- iii. Make video presentation that is at least 10 minutes long, and follow this up with a brief question and answer period.
- iv. Make an interactive, activity-based presentation that involves audience participation and will help your audience learn what you learned.

2. Career Exploration

- a. Find at least ten different occupations the heavily involve science. For each occupation, write the title of that occupation on the front of a 4x6 card and a brief description on the back of the card. Include additional information on the back about ideal knowledge and abilities for this occupation. When you finish, lay out the cards and sort them in several different ways (most interesting to least interesting for you, most education needed to least education needed, most mysterious (still) to least mysterious, any other way that makes sense to you). Discuss what you learned with your NOVA counselor. If you had to pick one of these occupations to learn more about, which would it be and why?
- b. Do **one** of the four activities below. Choose a different one for each NOVA award you complete.
 - i. Find a resource (internet, library, career center) for obtaining a *career assessment inventory*. Find at least two different such inventories. Complete the inventories, evaluate your results, and discuss with your NOVA counselor. Was there similarity in the results of the two inventories? Did the results indicate that STEM fields might be ideal for your interests and abilities? Were you surprised by the results? Do you agree or disagree with the results and why? Do the results suggest any specific next steps for you in preparing for your future?
 - ii. What is an internship/traineeship/apprenticeship? Find a job offering for an internship/traineeship/apprenticeship related to STEM. (Search online, at a library, or a career center. It need not be a job in your geographic area.) Discuss with your counselor how this job is related to STEM. What qualifications are needed for that position? Do you currently have those qualifications? If not, how long would it take you to acquire those qualifications? Describe what kind of a career choice this job might support and how.
 - iii. Write two different resumes. First, write a *current* resume describing your work history (if any), leadership training and experience, communication skills, current STEM knowledge, and awards. Second, write a hypothetical *two-years-from-now* resume

describing what you expect to be able to say about your accomplishments two years from now. Discuss with your counselor how you plan to achieve those accomplishments.

- iv. Set up and participate in a mock job interview. Find someone who works in a STEM field that interests you and ask if he or she would be willing to do a mock interview with you for a hypothetical internship at his/her company. You will need to do some research. Look for sample questions that are typically asked of job applicants. Look for sample questions that job applicants typically ask of interviewers. When the interview is over, reflect on how it went and discuss with your counselor what went well, what could have gone better, and what you would do differently if you had a second chance.

3. Science Activities (Choose 2)

Environmental Science: New Things from Old

This activity can be done individually or in groups.

Your task is to take a product that is typically thrown away or recycled and find a way to repurpose it into some new use. For example, old tires are being used to build road surfaces and to make playground mulch.

Part 1: Research. How are products adapted to other purposes and how does this help the environment? What are some examples of effective adaptation of commonly used products? (Provide photos.) What kinds of products would be ideal for repurposing?

Part 2: Development of Repurposed Product and Report. Chose a product and develop your own design for reusing the product. Is your adaptation something that has as much demand as the original product? What resources would be needed to carry out large scale implementation of your adaptations? Speculate on the environmental impact of using your adaptation over the production and use of something new in its place. Create a report that includes photos, illustrations, and demonstrations of how your adaptation can be scaled up to mass production.

Movie “Science”: Misconceptions, Misunderstandings, and Mistakes.

This activity can be done individually or in groups.

There are many popular movies with plots that involve space travel. Your task in this activity is to identify some scientific or technological advances that are possible and those that are not and explain.

Part 1: Research. Find a movie involving space, space travel, or life in space. Within that movie identify at least two instances of “scientific” principles that violate

currently accepted scientific principles or facts. What scientific principles are violated and how? Identify at least two technological or scientific advances in your chosen movie and explain how these could potentially come to be in the future. What hurdles will have to be overcome in order to develop these advances and why do you believe we can overcome these hurdles?

Part 2: Report. Create a report that helps others understand what you have learned. If you had been a scientist hired as a consultant on your chosen movie, what suggestions would you have made to the producers to make the movie more scientifically accurate or realistic?

Household Chemistry: Assessing the Safety of Household Cleaning Products

This activity can be done individually or in groups.

Chemistry isn't just for chemistry class! Most of us have chemicals lying around the house all the time in form of cleaning products, cosmetics, or even food. Some of the chemicals in cleaning products can be dangerous or deadly if used improperly or mixed with other chemicals. Your task is to identify what's in some common household cleaning products, and learn how to use Material Safety Data Sheets to identify possible hazards in the home.

Part 1: Research. First, pick at least three household cleaning products that are used every day (laundry detergent, dishwashing soap, cleanser, bleach, ammonia, and so on). For each product, make a list of the different chemicals listed as ingredients, particularly the active ingredient. Second, find a website that gives the Material Safety Data Sheets (MSDSs) for a given product or chemical. Read through the MSDS for each chemical. These papers tend to be cryptic and take a little bit of getting used to when reading, but all MSDSs provide the same types of information including: product name; name, address, and phone number of the company that manufactures the product; ingredients; acceptable exposure limits to the chemicals; hazard information; acute and chronic symptoms, carcinogenicity, and effects of overexposure; first aid measures; release measures; fire fighting measures; handling and storage information; physical and chemical properties; stability and reactivity data; and disposal methods.

Part 2: Summary and Report. Write notes about each chemical, especially information on hazards related to each chemical. For example, is the product listed as a possible carcinogen (cancer-causing agent)? What actions should be followed if you are overexposed to the product? What dangers are present if the product is mixed with other products? Are there any risks of using the product that you were unaware of? How should the product be stored to prevent overexposure or incorrect exposure to children? How should the product be disposed of, if you wish to switch to a new product before finishing it? Are there cleaning products available that are safer for human beings and better for the environment? Are products that are billed as "eco-friendly" really better than those that are not? Create a report that outlines a general

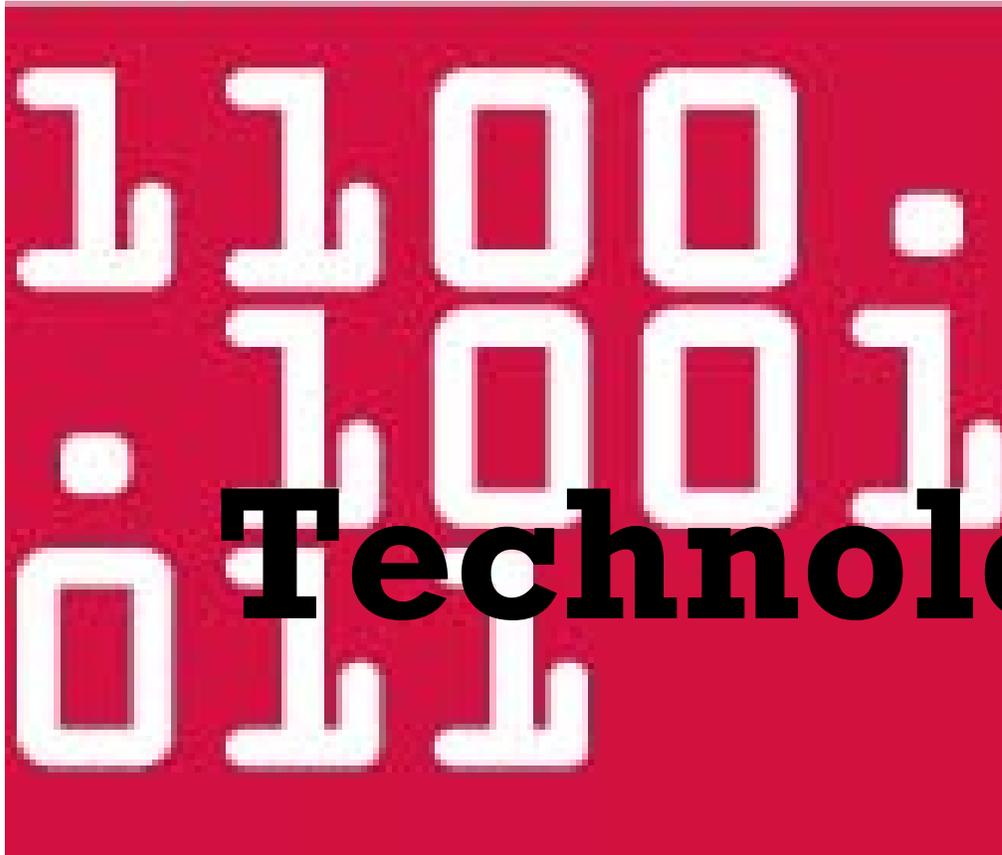
strategy for choosing, storing, and using household cleaners that helps ensure human safety and environmental integrity.

Establishing Truth in Science: The Scientific Method

This activity should be done by 2-4 individuals.

Part 1: Research and Debate Preparation. Define *the scientific method*. Research and learn how scientists establish hypotheses, theories, and laws. How does the establishment of “facts” or “rules” using *the scientific method* differ from the establishment of “facts” or “rules” in other environments, such as legal, cultural, religious, military, mathematical, cultural, or social environments? Research a modern controversial scientific subject. Find at least two competing theories on the subject. Each Venturer working on this activity should pick one of the competing theories to defend in a debate, and learn as much as possible about his or her theory.

Part 2: Debate, Analysis, and Report. Establish rules for how to conduct your debate ahead of time. Carry out the debate with an audience of fellow Venturers and/or others interested in the topic. There should be an opening round that describes the controversy in a way that makes sense to audience members (who will likely not have completed the research that you have). After both sides have presented their viewpoints, there should be a closing round in which you describe how scientists are dealing with the controversy. When all is said and done, analyze all the competing theories, decide which one is most convincing to you, and explain why. Create a report that describes the controversy, the competing theories, and your conclusions about how the scientific method can or can't contribute to the resolution of the controversy.



1. What is Technology?
 - a. Spend some time building your understanding of what the term *technology* means. Find at least three different written responses to the question, “What is technology?” Interview at least three different people who have an interest in technology, asking this same question of all three and following up with additional questions. (See suggestions for additional interview questions here.) Based on what you learned, prepare your own response to the question, “What is technology?” and discuss with your NOVA counselor.
 - b. Find and study at least three sources of information (television show, book, magazine article, internet site) related to a particular topic in the realm of technology. (All sources must relate to the *same* topic.) Learn the material presented. Discuss what you learned with your NOVA counselor. Prepare and give a presentation to your crew or another group approved by your NOVA counselor on what you learned. (See below for presentation options). Document your presentation with a one-page summary that contains a picture and a 1-2 paragraph description. Presentation Options (Choose a different one for each NOVA award you complete.)

- i. Make an informal, oral presentation involving a tabletop display along with discussion of what you learned.
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 - iii. Make video presentation that is at least 10 minutes long, and follow this up with a brief question and answer period.
 - iv. Make an interactive, activity-based presentation that involves audience participation and will help your audience learn what you learned.
2. Career Exploration
- a. Find at least ten different occupations that heavily involve technology. For each occupation, write the title of that occupation on the front of a 4x6 card and a brief description on the back of the card. Include additional information on the back about ideal knowledge and abilities for this occupation. When you finish, lay out the cards and order them in several different ways (most vital for human progress to least vital for human progress, most ubiquitous to scarcest, most to least training required, highest to lowest paid, most unexpected impact to most expected impact). Discuss what you learned with your NOVA counselor. If you had to pick one of these occupations to learn more about, which would it be and why?
 - b. Do **one** of the four activities below. Choose a different one for each NOVA award you complete.
 - i. Find a resource (internet, library, career center) for obtaining a *career assessment inventory*. Find at least two different such inventories. Complete the inventories, evaluate your results, and discuss with your NOVA counselor. Was there similarity in the results of the two inventories? Did the results indicate that STEM fields might be ideal for your interests and abilities? Were you surprised by the results? Do you agree or disagree with the results and why? Do the results suggest any specific next steps for you in preparing for your future?
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accomplishments two years from now. Discuss with your counselor how you plan to achieve those accomplishments.

- iv. Set up and participate in a mock job interview. Find someone who works in a STEM field that interests you and ask if he or she would be willing to do a mock interview with you for a hypothetical internship at his/her company. You will need to do some research. Look for sample questions that are typically asked of job applicants. Look for sample questions that job applicants typically ask of interviewers. When the interview is over, reflect on how it went and discuss with your counselor what went well, what could have gone better, and what you would do differently if you had a second chance.

3. Technology Activities (Choose 2)

Energy Technology

This can be done individually or in groups.

The technology to harness energy has always been a significant factor in human progress, from the pre-tech days of manually spun wheels, to water wheels, to the high-tech methods of hydroelectric power generation today.

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. Create a report that describes your field trip and what you learned. For the energy production and/or use that you learned about, describe the current state of technology, the historical trajectory that led to today's technology, and future directions for this technology. What is the cost, to our environment, our natural resources, and our economy of our current methods? Are the current methods sustainable over the long term?

Communication Technology

This can be done individually or in groups, but requires participation from 20-30 people.

Here is the scenario. You are the communication chair for a science fair being organized by your crew. Your job 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 things to everyone, other things to subgroups, and still other things to individuals.

Part 1: Communication Plan. First, solicit volunteers to serve as participants. Give each participant a mock role in your mock science fair. You'll need 20-30 such individuals. Second, from each participant gather at least two ways to contact him or her, as well as an emergency contact. Each participant should list his or her contact modes in order from most-likely-to-be received to least-likely-to-be-received. Third, set up plans for how you will get broadcast messages out to various subgroups, how you will get emergency messages out (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 taken ill. Think about what kinds of information you will need to communicate, because sometimes that influences the mode of communication and that should also be a part of your communication plans. Finally, test your plan by playing a few Mad Libs via your communication plan: send out requests for various types of words (verbs, adjectives, nouns, and so on) to various individuals and subgroups, making sure you cover your entire set of recipients or recipient groups. 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.

Part 2: Analysis and Report. Gather some statistics relevant to your communication plan and your participants. How many distinct modes of communication were used by your participants? Were there some modes of communication with which you were unfamiliar? What technology did you use for your broadcast communication messages? Is that technology the most effective mode of communication for one-on-one messages? Why or why not? Create a report that outlines your communication plan, how you implemented it, and how effective it was. What was the biggest difficulty? What was unexpected? What would you do differently if this was a real assignment for you?

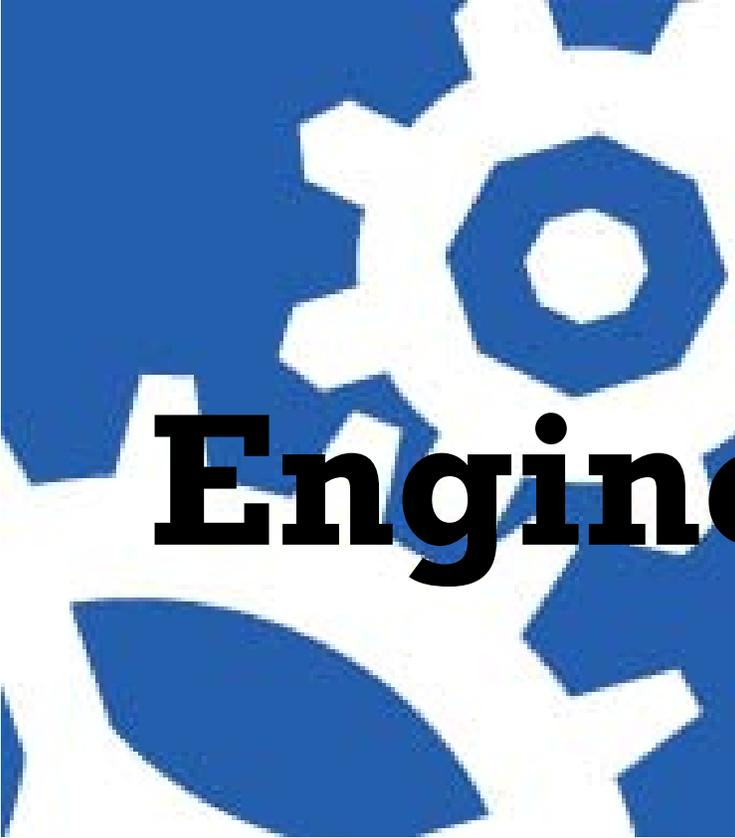
Entertainment Technology

This can be done individually or in groups.

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. Watch and study the material on the special effects. Do some supplemental research on some of these special effects to build your understanding of them. Take one scene in your movie, or even one frame, and describe in detail how that scene or frame was put together using various special effects. Which of these special effects could *you* implement (even if just crudely) if you were going 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. For a still photo, make a crude sketch of what you want the photo to look like. For a video, make a story board of the action sequence. In either case, describe the special effects you would use to create each element of the piece. What would you do first? How? What comes next? How does it all go together in the end? Do as many of the parts of the photo or video yourself as possible and describe what would need to be done by highly trained and/or educated professionals. Create a report that shows your understanding of special effects and how they might be applied to the photo or video that you envisioned.



Engineering

1. What is Engineering?
 - a. Spend some time building your understanding of what the term *engineering* means. Find at least three different written responses to the question, “What is engineering?” Interview at least three different people who have an interest in engineering, asking this same question of all three and following up with additional questions. (See suggestions for additional interview questions here.) Based on what you learned, prepare your own response to the question, “What is engineering?” and discuss with your NOVA counselor.
 - b. Find and study at least three sources of information (television show, book, magazine article, internet site) related to a particular topic within engineering. (All sources must relate to the *same* topic.) Learn the material presented. Discuss what you learned with your NOVA counselor. Prepare and give a presentation to your crew or another group approved by your NOVA counselor on what you learned. (See below for presentation options). Document your presentation with a one-page summary that contains a picture and a 1-2 paragraph description.
Presentation Options (Choose a different **one** for each NOVA award you complete.)

- i. Make an informal, oral presentation involving a tabletop display along with discussion of what you learned.
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- iv. Make an interactive, activity-based presentation that involves audience participation and will help your audience learn what you learned.

2. Career Exploration

- a. Find at least ten different occupations that heavily involve engineering. For each occupation, write the title of that occupation on the front of a 4x6 card and a brief description on the back of the card. Include additional information on the back about ideal knowledge and abilities for this occupation. When you finish this, choose a large city somewhere in the world and look up information about that city, such as transportation infrastructure, water and sanitation, climate and natural disaster propensity, geographical and geological challenges, natural resources in surrounding areas, etc. Now look back at your list of ten engineering occupations. For each occupation, speculate on what might be the impact to that large city if there was a severe, extended shortage of that type of engineer. Discuss your ideas with your NOVA counselor. If you had to pick one of these occupations that seems to be most crucial to the well-being of that large city and its citizens, which would it be and why?
- b. **Do one of the four activities below.** Choose a different one for each NOVA award you complete.
 - i. Find a resource (internet, library, career center) for obtaining a *career assessment inventory*. Find at least two different such inventories. Complete the inventories, evaluate your results, and discuss with your NOVA counselor. Was there similarity in the results of the two inventories? Did the results indicate that STEM fields might be ideal for your interests and abilities? Were you surprised by the results? Do you agree or disagree with the results and why? Do the results suggest any specific next steps for you in preparing for your future?
 - ii. What is an internship/traineeship/apprenticeship? Find a job offering for an internship/traineeship/apprenticeship related to STEM. (Search online, at a library, or a career center. It need not be a job in your geographic area.) Discuss with your counselor how this job is related to STEM. What qualifications are needed for that position? Do you currently have those qualifications? If not, how long would it take you to acquire those qualifications? Describe what kind of a career choice this job might support and how.

- iii. Write two different resumes. First, write a *current* resume describing your work history (if any), leadership training and experience, communication skills, current STEM knowledge, and awards. Second, write a hypothetical *two-years-from-now* resume describing what you expect to be able to say about your accomplishments two years from now. Discuss with your counselor how you plan to achieve those accomplishments.
- iv. Set up and participate in a mock job interview. Find someone who works in a STEM field that interests you and ask if he or she would be willing to do a mock interview with you for a hypothetical internship at his/her company. You will need to do some research. Look for sample questions that are typically asked of job applicants. Look for sample questions that job applicants typically ask of interviewers. When the interview is over, reflect on how it went and discuss with your counselor what went well, what could have gone better, and what you would do differently if you had a second chance.

3. Engineering Activities (Choose 2)

Deconstruct and Analyze: Bike Designs

This activity can be done individually or in small groups. Your task is to take apart a bicycle, analyze the components, and describe how the components work (both separately and together).

Part 1: Bike Choice and Set-Up. Think of a bicycle that you would feel comfortable dismantling and then look for a bicycle to dismantle that is a bit more complicated than that. Find a bike that's old, perhaps not completely in working order, and that isn't wanted anymore. Find a location for the project, someplace where you can take things apart, leave the pieces, and come back another time. Determine and gather the necessary tools. You are encouraged to find resources to help you with the deconstruction, such as written instructions on dismantling bicycles or a bicycle repair specialist willing to volunteer his/her time. (A bicycle repair specialist cannot touch the bike or the parts, or handle the tools during dismantling. You and any fellow Venturers must do all of the dismantling.)

Part 2: Deconstruction, Analysis, and Report. Deconstruct the bicycle. Take pictures as you work and make notes of what is happening in each picture. What are the major components of the bicycle? What parts make up each component? How do the components work together to make the bicycle go? What might cause a failure in one of the components? What kinds of failures can be fixed if you are out on the road or trail? What are the basic elements of keeping the bicycle well-maintained? Considering the intended rider and uses of this bicycle, what improvements to the design might be desirable? Create a report that communicates your understanding of

the experience and addresses the following points. (See report format options here.) Document the deconstruction process, your analysis of the components and how they work together, your analysis of failure possibilities plus maintenance requirements, and what these suggest about design improvements.

Build and Test: High Performance Paper Gliders

This activity can be done individually or in small groups. Your task is to measure how differences in glider 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 binder paper.

Part 1: Baseline design selection and test. Choose a sturdy paper glider to build and test. You do not need to design the glider, but may need to build it several times. Using a kit or building from scratch is acceptable, but the kit you use must allow you to make changes in some important characteristic. Develop a list of characteristics to test: flight distance, flight time, flight speed, load capacity, maneuvering capability, and so on. Establish a consistent method to measure each characteristic – you might need to repeat each test several times to establish an average, or find a way to remove an uncontrolled variable, like wind. Test your glider and refine your measurement methods until you feel that you are accurately measuring its performance.

Part 2: Modify and retest. Select a single variable to change in the glider's design, like wing size (or number), fuselage length, center of gravity, flap size, and so on. Build at least four different versions of your glider with changes in this variable (initially avoiding changes in other variables). Test the different versions and prepare a report that presents the results. Did certain changes result in improvements in some characteristics but losses in others? Did any changes improve or degrade all performance characteristics? If desired, experiment further with a second variable. Sometimes a single change, like increasing wing area, needs another change, like lengthening the distance to the stabilizer, to result in the desired improvement. Where possible, draw conclusions about modifying the glider design to improve specific characteristics of flight.

http://www.sciencebuddies.org/science-fair-projects/project_ideas/Aero_p009.shtml

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. In addition, you'll analyze the performance of your design, suggest modifications, and create a report on your experience.

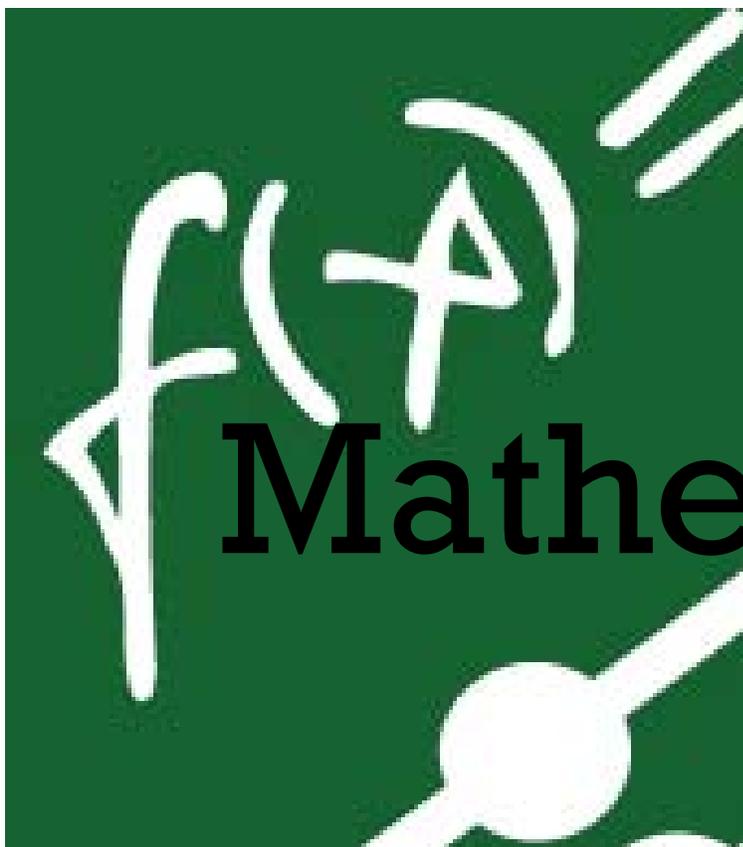
Part 1: Design and Contest Set-Up. All participants must come to consensus about how to conduct the contest. (Alternatively, you might want to break into divisions, where each division reaches its own consensus decisions. Youth with stronger STEM

backgrounds should adopt more challenging constraints and rules.) First, you must agree on constraints that the egg container must meet, such as dimensions, weight, allowable materials, disallowed elements, and so on. Second, you must agree on rules for the competition, 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. Third, you must communicate the constraints and competition rules to all participants. Fourth, design and build your container. Finally, conduct the contest.

Part 2: Analysis, Redesign, and Report. Analyze how your container performed. Did it perform as expected? Explain your design strategy. Given how your container performed, how would you redesign it, within the given constraints, to improve its performance? Would you alter the constraints? How and why? Finally, think about how this relates to the real world. In particular, how can you use what you learned in this activity to better understand how cars are designed to minimize the impact of car crashes on drivers and passengers? (You will have to do a bit of research to address this last question.) Create a report that communicates your understanding of the experience and addresses the following points. (See report format options here.) Describe your egg container, your design strategy, your analysis of its performance, your redesign ideas, and your understanding of how this connects to car crashes.

Resources

<http://www.tinkeringschool.com/>



Mathematics

1. What is Mathematics?
 - a. Spend some time building your understanding of what the term *mathematics* means. Find at least three different written responses to the question, “What is mathematics?” (Perhaps you can find quotes by famous mathematicians, past or present, on this topic.) Find and interview at least three different people who have an interest in mathematics, asking this same question of all three and following up with additional questions. (See suggestions for additional interview questions here.) Based on what you learned, prepare your own response to the question, “What is mathematics?” and discuss with your NOVA counselor.
 - b. Find and study at least three sources of information (television show, book, magazine article, internet site) related to a particular topic within mathematics. (All sources must relate to the *same* topic.) Learn the material presented. Discuss what you learned with your NOVA counselor. Prepare and give a presentation to your crew or another group approved by your NOVA counselor on what you learned. (See below for presentation options). Document your presentation with a one-page summary that contains a picture and a 1-2 paragraph description. Presentation Options (Choose a different one for each NOVA award you complete.)
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2. Career Exploration

- a. Below are five different occupations that heavily involve mathematics.

Actuary

Cryptoanalyst

Mathematician

Operations Research Analyst

Statistician

Find five additional occupations that heavily involve mathematics. (Search www.weusemath.org or www.maa.org/careers/ for ideas.) For each of these ten occupations, write the title of that occupation on the front of a 4x6 card and a brief description on the back of the card. Include additional information on the back about ideal knowledge and abilities for this occupation. When you finish, lay out the cards and sort them into piles. Which occupations involve analyzing data? Which occupations involve measurement? Which occupations involve creative problem solving? Which occupations are connected to other disciplines? Discuss what you learned with your NOVA counselor. If you had to pick one of these occupations to learn more about, which would it be and why?

- b. Do **one** of the four activities below. Choose a different one for each NOVA award you complete.
 - i. Find a resource (internet, library, career center) for obtaining a *career assessment inventory*. Find at least two different such inventories. Complete the inventories, evaluate your results, and discuss with your NOVA counselor. Was there similarity in the results of the two inventories? Did the results indicate that STEM fields might be ideal for your interests and abilities? Were you surprised by the results? Do you agree or disagree with the results and why? Do the results suggest any specific next steps for you in preparing for your future?
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2. Mathematics Activities (Choose 2)

From Simulations to Real Life: Modeling Bungee Jumping

This activity requires at least two people, and works much better with a group of 3-6 people.

Here is the scenario: the Acme Daredevil Adventure Company provides rock climbing, sky diving, 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, and now needs to work out the details of the new venture. The company has several sites planned for bungee jumping and each site is at different height. Your task is to simulate bungee jumping using rubber bands and an action figure (doll) and determine the ultimate length, or the number of rubber bands that can be used with your action figure at any given height and not cause any type of injury or fatality--but that allows your action figure to come as close to the floor as possible (for maximum thrills).

Part 1: Set-Up and Simulation. Tape a weight (or weights) to the doll's back so that s/he is heavy enough to stretch the "bungee cord" (the rubber band). Tie one rubber band to the doll's feet and drop it, head first, from various heights. Keep raising the jump height until the head no longer hits the floor. Once you get close to this height, perform three trials, measure the height of the drop each time, and take the average. (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 at least 6 different numbers of rubber bands. Use a chart to help you organize and record your data.

Part 2: Analysis and Report. Use graph paper to draw a scatter plot of ordered pairs of the form (*number of rubber bands, average drop height*). Do the points appear to lie on or near a line? Find such a line, either by "eyeballing it" and drawing it onto the scatter plot, or (for Venturers with more mathematics background) by finding the line of best fit. How can you use the line to make predictions? Complete the following sentence: "If the height of the drop is ___ then I predict that the number of rubber bands needed is ___." Now, test your prediction. Did the prediction match reality? How far off was it? A little? A lot? What errors or issues arose that

may have thrown off the results of your simulation? Test at least 3 more predictions. What if you were dropping your action figure from the top of _____? (Choose your favorite location with a view from high above the ground.) How many rubber bands would you need? Now, consider the realities of bungee jumping with real human beings using real bungee cords and equipment. What factors would need to be considered when testing this equipment to develop safety protocols? Can you find reliable statistics on the risk of serious injury or death while bungee jumping? Bungee jumping is one of the high adventure activities that is expressly disallowed by the Boy Scouts of America. What do you think of this policy? Create a report to the Risk Management Board of the Acme Daredevil Adventure Company that describes your simulation, displays your simulation data in a chart and graph, describes how your data led to your ability to make predictions about safe bungee jumping heights, and how various issues might have impacted your predictions.

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

This activity can be done individually, but works much better with 3-6 people.

Here is the scenario: you have lined up a summer job as a junior park ranger at Yellowstone National Park and you know that lots of visitors come to see Old Faithful Geyser. Lots of visitors arrive just after Old Faithful has erupted and typically, they 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. Begin by finding information about geysers in general and their behavior. Then find data on wait times between eruptions for Old Faithful. You need all of the wait times for 3 entire days. Each additional Venturer must use wait times for different days. Create at least two graphical displays of your data and formulate your initial prediction strategy. Share your graphical displays and your prediction strategy with fellow Venturers and/or your NOVA counselor.

Part 2: Further Analysis, Refinement of Prediction Strategy, and Report. How much variability do you see from day to day; how much within a single day? Is knowledge of one wait time sufficient to predict the next eruption? What patterns in the data are illuminated (or perhaps obscured) in the different graphical displays? Is there a specific type of graph that best illustrates the wait time pattern for Old Faithful? Do you wish to refine your prediction strategy? If so, why and how? If not, why not? Why are there patterns in the Old Faithful data? Is there a geological explanation? Create a report that addresses these points, describes your prediction strategy, includes your graphical displays, and describes how your graphical displays support your strategy.

A Paradox of Counting: Voting Methods and Fair Decisions

This activity can be done individually or with a group of 2-6 people, and requires cooperation from about 20-30 individuals.

Here is the scenario: your crew wants to plan a super activity for next summer, but cannot agree on what that activity should be. There are four options being considered and your crew decides to vote. Your task is to collect ballots and tabulate results using several different voting

methods. (Note: this is not a binding decision on your crew! It's an exercise, but one that will be more meaningful if you use real-life possibilities.)

Part 1: Ballot Set Up, Gathering, and Tabulating. First, decide on four super activities that your crew would genuinely be interested in doing next summer. (Aim for four genuine competitors, of which no single choice is likely to receive a majority of the votes.) Create ballots on which each voter can list his/her first, second, third, and fourth choices from among the four prospective super activities. Next, find 20-30 crew members, prospective guests for the super activity, crew leaders, parents, and so on, to each complete one ballot. Each voter should vote sincerely, without trying to strategize. Third, do some research and learn how to tabulate winners using each of the following four voting methods: (a) plurality method, (b) Borda count method, (c) plurality-with-elimination method (sometimes called the instant runoff method), and (d) pairwise comparison method (sometimes called Copeland's method).

Part 2: Analysis and Report. As you look at the results of each voting method, what do you notice? Is each method *fair*? If so, then how? If not, then why not? How would the results change if 2-3 voters had cast strategic ballots (instead of sincere ballots) in an effort not to "waste their votes"? Which of these voting methods do you believe is the right voting method for this decision in your crew? Why? Consider how we elect the president of the United States of America. What voting method do we use? What are its advantages and disadvantages? Does each voting citizen in the U.S. have an equal say in the vote tabulation? Is it possible for citizens to cast strategic votes and influence the outcome of a presidential election? 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.



Venturing NOVA Notes

What follows are additional notes for Venturers on the Venturing NOVA Award elements. I envision that these notes would be hotlinked to the basic requirements.

Primary credit for part (a) in Task 1 of each Venturing NOVA, including the additional interview questions below, goes to Chris Enright, Colorado School of Mines. I took his suggestions and modified them to produce these elements of the Venturing NOVA awards.

Notes on Venturing NOVA Task 1a (all options)

This task involves both networking (finding people with specific knowledge and abilities) and interviewing (setting up interviews, asking and answering questions, practicing courtesy in a business-like interaction). These are valuable communication skills. If you intend to work towards the Venturing SuperNOVA, you will be creating a Communication Portfolio in which you summarize communication skills and knowledge that you have gained while working on your NOVA and SuperNOVA awards. Summarize your networking and interviewing skills as you go along on these tasks, so that they can be included in your SuperNOVA Communication Portfolio.

“What is Science?” Additional Interview Questions (Science Task 1a)

Here are additional interview questions to consider. You might ask 2-3 of these of each person you interview.

1. Why is the scientific method so universal?

2. What is the distinction between hypothesis, theory, and fact, relative to scientific thought?
3. Can you give me an example of how the boundaries between scientific disciplines may not exist in a clear way or where extensive overlap exists?
4. What does it mean to do scientific research and what is the distinction between pure research and applied research?
5. How is scientific research often conducted in the real world, either in a public or private sector setting?
6. Is there a scientist whose work you respect more than most? Why? What contributions did he or she make to the progression of science?

“What is Technology?” Additional Interview Questions (Technology Task 1a)

Here are additional interview questions to consider. You might ask 2-3 of these of each person you interview.

1. How has the definition of technology changed throughout history?
2. What is the difference between low technology and high technology? Can we still solve some problems effectively and efficiently with low technology?
3. What are some of the limitations of modern technology?
4. What are the potential hazards from too much reliance on technology?
5. What technologies do you anticipate will be crucial to human progress in the next 100 years?
6. What technologies do you anticipate will fall by the wayside, as new technologies are developed in the future?

“What is Engineering?” Additional Interview Questions (Engineering Task 1a)

Here are additional interview questions to consider. You might ask 2-3 of these of each person you interview.

1. What are the steps in the engineering design process?
2. How do *you* go about understanding how a machine or a system works? For example, understanding how _____ works. (Choose a machine or a system.)
3. How would you measure the efficiency of that (the one in #2) machine or system?
4. How do you use science, technology, and mathematics in your work?
5. How do ethics play a role in engineering?
6. What do professional engineers do?

“What is Mathematics?” Additional Interview Questions (Mathematics Task 1a)

Here are additional interview questions to consider. You might ask 2-3 of these of each person you interview.

1. How important are examples, non-examples, and illustrations in understanding mathematics?
2. What is the importance of reasoning and proof in mathematics?
3. What was a particularly difficult topic in mathematics for you to learn in school and how did you eventually overcome this difficulty?
4. What is the difference between pure mathematics and applied mathematics?
5. How is mathematics used in _____? (science, engineering, technology, your field, and so on)

6. Why is mathematics important?

Notes on Venturing NOVA Task 1b (all topics)

- Look ahead to your options in Task 3. Many of those options involve research of some kind. A judicious choice of a topic for Task 1b can help you with Task 3.
- Audiovisual media productions can be found on Discovery Channel, Science Channel, National Geographic, History Channel, and PBS, among others.
- Magazine sources include but are not limited to Popular Science, Science Illustrated, Discover Magazine, Odyssey, and Scientific American.

Notes on Venturing NOVA Task 3 (all topics, all options)

No matter what options you choose in Task 3 of each NOVA award element, you will need to create a report. Reports are a regular part of the work of professionals in various STEM fields, so it will be helpful. You may choose from any of the formats below for your report, or you can create a hybrid of these formats, or create something entirely new as long as your NOVA counselor approves. The objective is for you to communicate what you learned to others in a way that helps them understand what you learned and how you learned it. For each format, you are encouraged to include multiple ways of presenting information and to employ the use of technology to aid in creating a polished presentation.

1. Oral report – classic in-person presentation
2. Written report – classic hard copy
3. Poster Presentation – classic hard copy
4. Virtual Poster – see Glogster.com
5. Video Production