



Designed to Crunch

This module is designed to help Scouts BSA 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 of math-related shows or documentaries that involve scientific models and modeling, physics, sports equipment design, bridge building, or cryptography. You may choose to watch a live performance instead of watching a media production. Then do the following:
 - (1) Make a list of at least five questions or ideas from the show(s) you watched.
 - (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, and TED Talks (online videos). You may choose to watch a live performance or movie at a science museum instead of watching a media production. You may watch online productions with your counselor’s approval and under your parent’s or guardian’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 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—beanZ, Plus, Owl, How it Works, Discover, National Geographic, Nature, Odyssey, Popular Mechanics, Popular Science, Science Illustrated, 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, and 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 ideas with your counselor.
2. Complete ONE merit badge from the following list. (Choose one that you have not already used toward another Nova award.) After completion, discuss with your counselor how the merit badge you earned uses mathematics.

American Business	Drafting	Radio
Animation	Entrepreneurship	Signs, Signals and Codes
Chess	Orienteering	Surveying
Digital Technology	Personal Management	Weather

3. Choose TWO from A or B or C or D and complete ALL the requirements for the two you choose. (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](http://www.wikihow.com/Calculate-Your-Horsepower)

Website: <http://www.wikihow.com/Calculate-Your-Horsepower>

- (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.
- B. Attend at least two track, cross country, or swim meets. You may substitute any sport where there are timed events.
- (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 record 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. Then choose two players. Keep track of their efforts during the game. (Make sure you record 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 record your data and calculations.) Then 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 points—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.

4. Do ALL 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 this affects 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.

Designed to Crunch **Counselor notes**

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

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 - 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. You may choose to watch a live performance instead of watching a media production. Then do the following:
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 - (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 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

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- 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, and 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 ideas with your counselor.
2. Complete ONE merit badge from the following list. (Choose one that you have not already used toward another Nova award.) After completion, discuss with your counselor how the merit badge you earned uses mathematics.

American Business	Drafting	Radio
Animation	Entrepreneurship	Signs, Signals and Codes
Chess	Orienteering	Surveying
Digital Technology	Personal Management	Weather

3. Choose TWO from A or B or C or D and complete ALL the requirements for the two you choose. (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.

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 <https://www.web-cars.com/math/horsepower.html>.

Helpful Links

"How to Calculate Your Horsepower": wikiHow

Website: <http://www.wikihow.com/Calculate-Your-Horsepower>

- 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 ($m \cdot 9.80 \cdot h$)/ t , where:

m = mass (your weight) in kilograms

a = acceleration (9.80 m/sec² is the acceleration caused by Earth's gravity)

h = height of staircase in meters

t = time in seconds

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

Work = mah

Power = mah/ t

Work (or energy) is measured in newton meters or joules; power is measured in joules/second or watts.

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

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

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

- B. Attend at least two track, cross country, or swim meets. You may substitute any sport where there are timed events.
- (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 record 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. Then choose two players. Keep track of their efforts during the game. (Make sure you record 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

Helpful Links

The following are some suggested sites. You may find other sources on your own.

“SoccerXpert.com Soccer Stats”: SoccerXpert.com

Website: <https://www.soccerxpert.com/docs/GameStats.pdf>

The Baseball Scorecard

Website: <https://www.baseball.org/il/images/Scorecard.pdf>

“How to Take Statistics at a Basketball Game”

Website: <https://www.masterclass.com/articles/essential-basketball-statistics-to-learn>

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 record your data and calculations.) Then 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 points—Attempted, percent completed
 - (2) Offense
 - (e) Number of first downs
 - (f) 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
 - (g) 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.

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 this affects 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 Scout 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.