

## Counselor Edition - Cub Scout NOVA – Cruncher!

1. Watch or read, choose one:
  - a. Watch an episode or episodes (about an hour total) of NOVA or other media production\* that involve math or physics (math and physics are in almost every kind of invention – cars, airplanes, telescopes. Math also includes cryptology).
    - i. Make a list of at least two questions or ideas from each production
    - ii. Discuss the ideas and questions with your counselor
  - b. Read one long or two short magazine articles\*\* that show(s) how scientists use math.
    - i. Make a list of at least two questions or ideas from the article(s)
    - ii. Discuss the ideas and questions with your counselor
  - c. Do a combination of reading and watching
    - i. Make a list of at least two questions or ideas from the article or production
    - ii. Discuss the ideas and questions with your counselor
2. Complete the Mathematics pin
3. Calculate (Choose two options. Keep your work to show your counselor – the necessary information to make your calculations may be found in a book or on the internet. You may work with a parent or your counselor on these calculations.)
  - a. Your weight

Earth's gravity is the standard, so it is set at 1, one gravity. When astronauts and pilots talk about pulling g's, they are referring to how much gravity they are experiencing related to Earth's gravity. On earth, we are pulling 1g. If a pilot is pulling 2g's, it is as if he weighs twice as much as he normally weighs. In outer space, our bodies are not affected strongly by gravity; there are 0g's, and we feel weightless. Other solar bodies have different gravities. Weight on another planet or the moon is calculated by multiplying an earth weight by the fraction of the gravity on the other planet or moon.

- i. On the moon  
Earth weight (in pounds) X 0.166 = **Moon** weight
- ii. On Jupiter  
Earth weight (in pounds) X 2.36 = **Jupiter** weight
- iii. On a planet that you choose  
Earth weight (in pounds) X 0.378 = **Mercury** weight  
Earth weight (in pounds) X 0.907 = **Venus** weight  
Earth weight (in pounds) X 1.000 = **Earth** weight  
Earth weight (in pounds) X 0.377 = **Mars** weight  
Earth weight (in pounds) X 2.36 = **Jupiter** weight  
Earth weight (in pounds) X 0.016 = **Saturn** weight  
Earth weight (in pounds) X 0.889 = **Uranus** weight  
Earth weight (in pounds) X 1.12 = **Neptune** weight

**Pluto is no longer considered a planet because it is so small.** Pluto is now considered a planetoid. A human would weigh less on Pluto than on Earth's moon. Earth weight (in pounds) X 0.059 = **Pluto** weight  
Earth weight (in pounds) X 28 (27.97) = **Sun** weight

b. The height of (Do two)

[http://www.associatedcontent.com/article/5588962/how\\_to\\_calculate\\_the\\_height\\_of\\_a\\_tree.html](http://www.associatedcontent.com/article/5588962/how_to_calculate_the_height_of_a_tree.html)

- i. A tree
- ii. Your house
- iii. A building of your choice

**Step 1:**

On a sunny day, choose a tree that casts a clear shadow. Trees and other tall objects that stand by themselves are easiest to work with.

**Step 2:**

Hold a ruler perpendicular to the ground, right next to the tree.

**Step 3:**

Measure the shadow of the ruler, and record the measurement. Call this measurement "A."

**Step 4:**

Measure the shadow of the tree. Call the tree shadow measurement "B."

**Step 5:**

Multiply measurement "B" by 12. Then divide that answer by measurement "A." This answer is the height of the tree in inches.

- c. The volume of air in your bedroom (Volume=length x width x height. Make sure your measurements have the same units – all feet or all inches.) The answer will be in cubic feet or cubic inches. (ft<sup>3</sup> or in<sup>3</sup>)

4. Design – Secret Codes

- a. Look up, then tell your counselor
  - i. About Cryptography

The first recorded use of cryptography, the practice and study of hiding information, was when Julius Caesar used a substituted letter code to hide information. Cryptography has been very useful during wars, transmitting information without revealing it to the enemy (unless the code is broken). The major use of cryptography today is with computers, especially in finance and electronic data transmissions. ATM cards, computer passwords, PIN and TIN numbers depend on cryptography.

- ii. At least three ways secret codes or ciphers are made

A code is a symbol or signal used to represent or communicate something else. A cipher is a way to make a secret message by changing or rearranging the letters in the message. Codes replace words, phrases, or sentence with groups of letters or numbers; ciphers rearrange or substitute letters. Examples of codes and ciphers include, but are not limited to:

- Transposition ciphers - rearrange the letters in a word.
- Book Code/Dictionary Code – Use two of the same book (dictionaries work best). For each word in the code, give the page number, (column number for a dictionary), row

number, and word number. Usually it is best to use two or three digits for each coded word, using zeros as place holders.

- Letter shifts – shift every letter in the alphabet a set number of places.
- Number substitutions - Assign every letter a number. This can be combined with letter shift.
- Keyboard ciphers – using a keyboard, shift a set number of places.
- Date shift ciphers - <http://www.wikihow.com/Create-Secret-Codes-and-Ciphers>
- Stacked ciphers – combine two or more codes and/or ciphers
  - iii. How secret codes and ciphers relate to mathematics

Many ciphers can be broken by using frequency analyses, for example, the letter e is the most frequently used letter in the English language. Ciphers are pairs of algorithms, rules or set of rules to solve a problem, to encrypt and decrypt information. Since the early 20<sup>th</sup> century, cryptography is makes a much more extensive use of mathematics, including information theory, computational complexity, statistics, number theory, and abstract algebra.

- b. Design a secret code or cipher
  - i. Write a message in your code/cipher
  - ii. Share your code/cipher with your counselor

Links – to start your study

1. Calculations
  - a. Weight on other planets
    - i. [http://www.essortment.com/all/weightonplan\\_rvrp.htm](http://www.essortment.com/all/weightonplan_rvrp.htm)
    - ii. [http://www.intrepidmuseum.org/Education/Teacher-Resources/documents/Space\\_9-12Post.aspx](http://www.intrepidmuseum.org/Education/Teacher-Resources/documents/Space_9-12Post.aspx)
  - b. Height of trees or other tall things
    - i. [http://www.associatedcontent.com/article/5588962/how\\_to\\_calculate\\_the\\_height\\_of\\_a\\_tree.html](http://www.associatedcontent.com/article/5588962/how_to_calculate_the_height_of_a_tree.html)
  - c. Volume of a room
    - i. [http://www.ehow.com/how\\_2266390\\_calculate-volume-room.html](http://www.ehow.com/how_2266390_calculate-volume-room.html)
2. Secret Codes
  - a. <http://www.nsa.gov/kids/>
  - b. [http://www.cerias.purdue.edu/education/k-12/teaching\\_resources/lessons\\_presentations/cryptology.html](http://www.cerias.purdue.edu/education/k-12/teaching_resources/lessons_presentations/cryptology.html)
  - c. <http://nrich.maths.org/2197>
  - d. <http://www.wikihow.com/Create-Secret-Codes-and-Ciphers>

\*(Some media examples are the Discovery Channel, Science Channel, National Geographic, and the History Channel.)

**\*\***(Examples of magazine sources include Odyssey, Know : the Science Magazine for Curious Kids, Kids Discover, National Geographic Kids, Owl or **OWLkids Online**. You may wish to look at an article from Popular Mechanics or Popular Science with one of your parents.)