CREATING A CIPHER DISK AND DECRYPTING MESSAGES

LESSON OVERVIEW

Grade Levels: 6-8

In this lesson students will learn about cryptography, create their own cipher disks, and use them to solve secret messages in an attempt to thwart invading Martians! Extension activities allow students to research additional cipher methods and their uses. In this extension, students will create their own cipher and use this to encrypt plain text and allow others to decrypt the cipher text using the new method.

STANDARDS

CCSS MATH.PRACTICE.MP1	Make sense of problems and persevere in solving them.
CCSS MATH.PRACTICE.MP2	Reason abstractly and quantitatively.
CCSS MATH.PRACTICE.MP5	Use appropriate tools strategically.

OBJECTIVES

- Students will create cipher disks.
- Students will encrypt and decrypt information using ciphers.
- Students will research and create their own ciphers.

MATERIALS

- Copies of the blank cipher disk (1 per student)
- Brads to secure cipher disk (1 per student)
- 1 completed cipher disk for class demonstration
- Optional: Internet access to http://smartspaceniu.com/cryptography-cracking-the-code for the online game *Cryptography: Cracking the Code* and extension activities

PROCEDURE

STEP 1: Introduce cryptography. Ask students to brainstorm applications for cryptography and share with the class. Discuss some historical and current uses of cryptography (war, espionage, computing, banking, finance, etc.). Additional information can be found at http://smartspaceniu.com/files/Cryptography-Teacher-Guide-Brian-Veitch.pdf

STEP 2: Go over the definitions of cryptography terms (found in the *Guiding Information* below).

STEP 3: Show students an example of a cipher disk and how it works. Have the class come up with a word or message they would like to encrypt. Encrypt the message together as a class with the class cipher disk. Pick a word or phrase of your own and have the students decrypt the text.

STEP 4: Hand out copies of the blank cipher disk sheet. Students must design and create their own cipher disks. The answers to the questions on the handout are "The Martians are coming" and "d. 20."

STEP 3: Provide a setting for the activity. You are living on Mars when you discover that the Martians are planning to invade the Moon for its resources. You need to get a message to your friend on the Lunar base in order to warn them. You must encrypt your message so that the Martians do not understand your warning message. Students will take turns being the message sender, the message receiver, and the Martian secret service.

STEP 4: Assign students to groups of 3. One student will be the message sender on Mars, one student will be the Martian secret service, and another student will be the message receiver on the Lunar base. Students will each take turns in these rolls.

STEP 5: All students should create a short warning message in secret. They will choose a key for their cipher disk and then encrypt the message.

STEP 6: One at a time in each group, students will be the message sender. They will share the key with the receiver on a separate piece of paper but not with the Martian. The cipher text message will be shared with both the receiver and the Martian. The receiver and the Martian will try to decrypt the ciphertext at the same time. If the receiver decrypts the message first, the Lunar base will be warned and prepared in time. If the Martian decrypts the message first, then the Martians will invade sooner and takeover the unprepared Lunar base.

STEP 7: When everyone is done, ask students if any Martians decrypted the messages. There will be very few or no Martians who decrypted the messages because they did not have the keys. Discuss how it takes longer to decrypt cipher text without a key since you have to try every key. Discuss how encryption is not completely secret because every cipher can be decrypted with enough time, especially with modern technology and automated decryption tools.

STEP 8: As an extension activity have students research other types of ciphers other than Caesarian cipher disks. Have students create or modify their own ciphers based on their research. Students can then create secret messages and share their ciphers for others to decrypt.

STEP 9: Students can share their cipher methods with the class, allowing the class to attempt to decrypt their created cipher text.

GAME: The online game *Cryptography: Cracking the Code* is available at http://smartspaceniu.com/cryptography-cracking-the-code/

GUIDING INFORMATION

Vocabulary

Cryptography	is the science of the enciphering and deciphering of messages in secret code or cipher text.
Plain text	is the original message that is sent. It can be made up of letters, numbers, characters, or symbols.
Encryption	is the disguising of plain text using some method.
Cipher text	is the result of encryption. It can be letters, numbers, or characters. It should be unreadable without a key.
Decryption	is the process of undoing the encryption. The original plain text is the output.
Key	is something that is used to encrypt the message. It is like a password that disguises and reveals the message.

Visit http://smartspaceniu.com/cryptography-cracking-the-code/ for more resources and information on cryptography and other cryptographic methods.

CREATING A CIPHER DISK HANDOUT

The Cipher Disk

This tool was originally created by Leon Battista Alberti to encipher and decipher secret messages. Though the alphabet on the disk to the right differs from the original disk, the disks function similarly. The outer ring refers to the plain text, while the inner ring references the cipher text. The letters align to create the key. The key number refers to the alignment of the letters and differs based on the position of the letters on the inner ring.

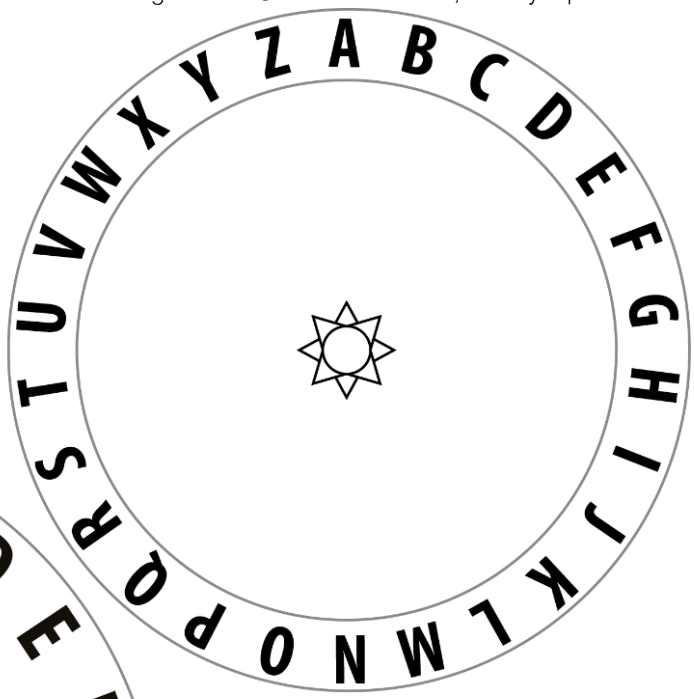
Directions for Assembly

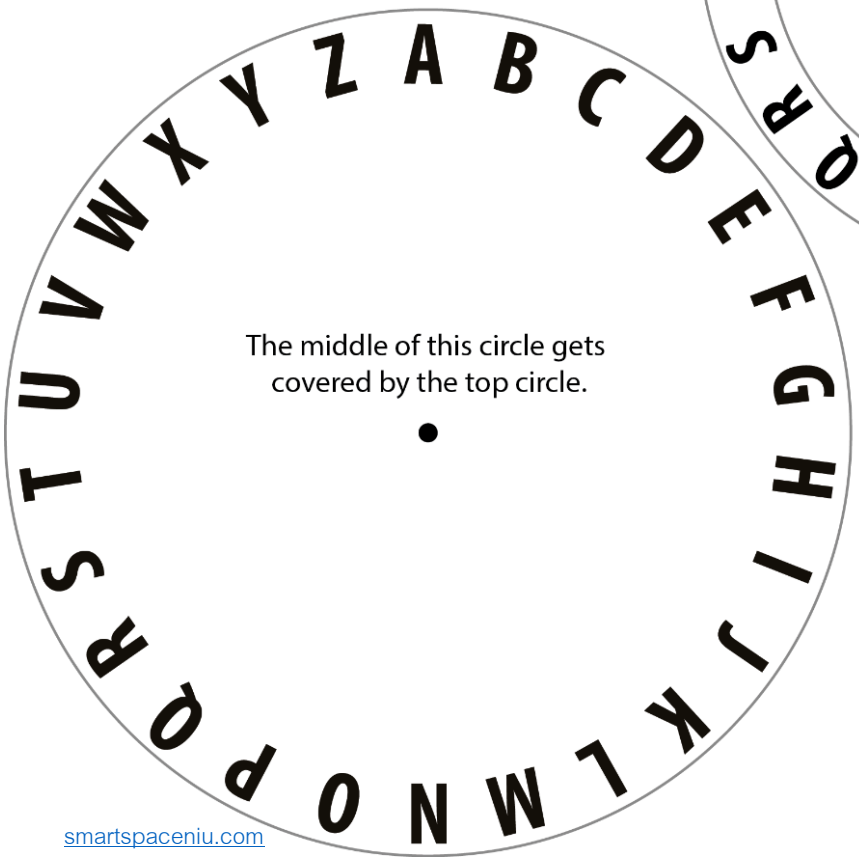
1. Cut around the outer edge of each circle.
2. Place the smaller circle on top of the larger circle.
3. Poke a brad through the middle of the circles.
4. Spread the ends of the brad on the back side.

Determining the Key

To determine the key, turn the inner ring counter clockwise and count the number of letter positions to the destination letter.

- When A in the outer circle is aligned with A in the inner circle, the key equals 0.
- When A in the outer circle is aligned with B in the inner circle, the key equals 1.
- When A in the outer circle is aligned with C in the inner circle, the key equals 2.





Can you solve this encrypted message that uses a key that equals 11?

ESP XLCETLYD LCP NZXTYR

When A in the outer circle is aligned with U in the inner circle, what does the key equal?

a. 6
b. 11
c. 17
d. 20

RUBRIC

	Target (3)	Meets (2)	Partially Meets (1)	Does Not Meet (0)
CIPHER DISK DESIGN	Does a great job showing an understanding of design for a purpose.	Does an okay job with showing an understanding of designing for a purpose.	Tries but has great difficulty showing an understanding of the design process.	Does not show an understanding of design.
PROBLEM SOLVING	Uses an efficient and effective strategy to solve problems.	Typically uses an effective strategy to solve problems.	Sometimes uses an effective strategy to solve problems, but not consistently.	Rarely uses an effective strategy to solve problems.
COLLABORATION	Works well with others and discusses ideas in a fair, respectful, encouraging way and is considerate of the feelings of others.	Works okay with others and discusses ideas in a fair, respectful way, but may not be encouraging. Considers the feelings of others.	Works with others, but does not contribute a fair share of work OR is discouraging and does not consider the feelings of everyone.	Does not work well with others and/or discusses ideas in an unfair, disrespectful way.
REQUIREMENTS	Meets all of the requirements for the project.	Meets most of the requirements for the project.	Meets some of the requirements for the project.	Does not meet the requirements for the project.
DEMONSTRATION OF KNOWLEDGE OF CONTENT IN DISCUSSIONS AND ACTIVITIES	Does a great job showing an understanding of the content covered in class.	Does an okay job with showing an understanding of the content covered in class.	Tries but has a difficult time showing an understanding of the content covered in class.	Does not show an understanding of the content covered in class.
Total				/15