Encryption

Have you ever communicated with a friend using a secret code? Maybe together you crafted an intricate and new way of representing letters, assigning unique symbols and characters in place of normal letters...or maybe you both agreed upon certain code words, that would imply a meaning that only you two understand. Or maybe you substituted numbers in the place of letters. So many possibilities!

And why did you create a secret code? Well, of course, it is super fun! But sometimes, we use codes when we need to communicate information that we don't want other people to understand. This is actually something that people use every day, and is an important part of computer science. It is called encryption. Encryption is the process of transforming a message so that its intended message is not understood by unintended recipients. In order to share information across the internet, we use very complicated instructions that allow the computer to scramble information and then put it back together. People need to share all kinds of information through the internet that they want to be kept private (personal data, health information, credit card info, banking transactions). So we need very complex and impossible-to-crack methods of encrypting information.

These activities focus on very simple and straight-forward methods of encrypting information, so that all of the little spies and detectives at home can get started with their own secret codes by simply understanding the basic ideas behind how encryption works.

Activity 1: Creating a Caesar Cipher

Overview
If you understand *how* a secret message was encrypted you could potentially decrypt (decode) the message. The instructions or methods by which a message is encrypted is called a cipher. A cipher is a set of steps that are followed in order to encrypt a message. You can see that if you have the cipher, you can crack the code! That's why the cipher is not always known, and in fact may be the thing that you and your friend share, if you want to exchange secret messages.

This first activity explores the Caesar Cipher, which is a kind of substitution cipher. It is called a substitution cipher because it substitutes different letters for the actual letters. The Caesar Cipher is named after Julius Caesar who used it to send messages to the military so that the enemy would not understand. Encrypted messages are created by shifting letters a certain number of spots - if you know this number of spots (1 - 26) then you can decrypt the message.

Objective
Children will understand how substitution ciphers work by making a Caesar Cipher. With this cipher, children will understand how we can shift letters of the alphabet a certain number of spaces to create a coded message.

Ages: 4 - 13 years

Materials
-printed out templates from **Encryption Template PDF**
-scissors
-paper
-ruler
-pencil
-marker

*nice to have: protractor (if you don't have access to a printer)

Setting Up
Find a space on the table that is clear of distraction and provides enough room to comfortably cut and work.

Process

1. Print the **Encryption Template PDF**; follow the instructions to cut where indicated.

2. You will have two circles. Depending on the age of the child, work with them to write down the letters of the alphabet, so that there is a letter in each space. (See the image below)

3. Do this for both circles.

4. With a pin, or a paper brad/fastener, attach the smaller circle to the larger on, making sure that the center of each circle is matched up.

5. If you have a paper brad/fastener, you can attach the two; if you are using a push pin, you may want to attach it to a piece of cardboard. (You can also glue the printed out circles on to heavier paper before cutting them, so that they are a bit stronger - this makes it easier to turn, but not necessary)

6. Line up the circles so that the letters line up and match.

7. This is our cipher! We can set our cipher for whatever kind of code we want to create. This cipher is considered a substitution cipher, because we are substituting a new letter for the intended letter. The process we use to substitute the letter isn't random of course, there is a method - this is the significance of our cipher!
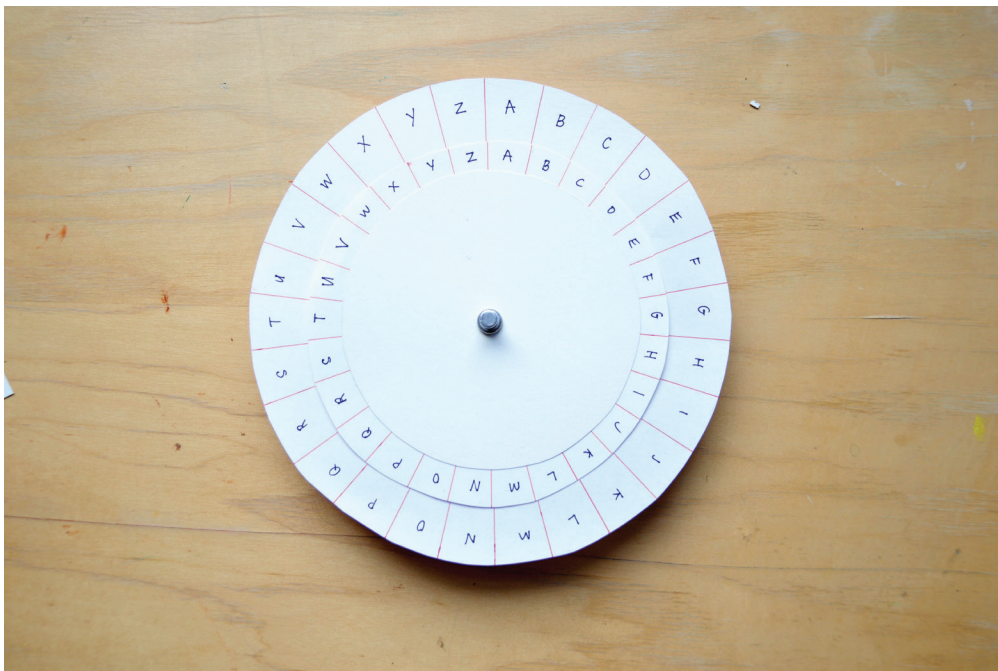
Caesar Cipher

8. Show the child how we can turn the two circles. Let them try for a bit. Show how the outer, larger circle can stay stationary, and we can align both of the "As" to the top, like 12 on a clock.

9. To transform our message, we will be shifting letters a certain number of spaces - if we know how many spaces the number is shifted, then we can decrypt the message! We will simply be turning the circle (turn the smaller inner circle counter-clockwise) a certain number of steps. This is the shift number, the number of times that the letter has been shifted. Together turn the inner circle 2 steps to the left, keeping the larger outer circle stationary with the A at the top. What aligns with the A? (answer: C)

10. Align it back to A, and shift it 4 steps...(The letters in the inner, smaller circle will be the coded letters). Continue experimenting together with various numbers of steps, 1 - 26, until the child understands how to turn the circle a certain number of steps and how the inner letter will be substituted for the outer letter.

11. Write down your child's name, or have your child write it:

P e n e l o p e

12. Shifting the letters by 3 places (to the left), can you write your name in code?

S h q h o s h

13. Now you know how to use the Caesar Cipher to encode secret messages! Depending on the age and interest of the child, try a few of these examples:

a. Create a coded message for your child using the Caesar Cipher. Tell your child the shift number (this is the number of spaces that the letters have been shifted, by turning the inner circle counter-clockwise a certain number of steps). Ask the child to decode the secret message.

b. Write the child's name (or something else they will immediately agree on, i.e. pet's name, favorite food) in coded text, randomly choosing the shift number...then, without telling the child the shift number, ask them to try and figure it out.
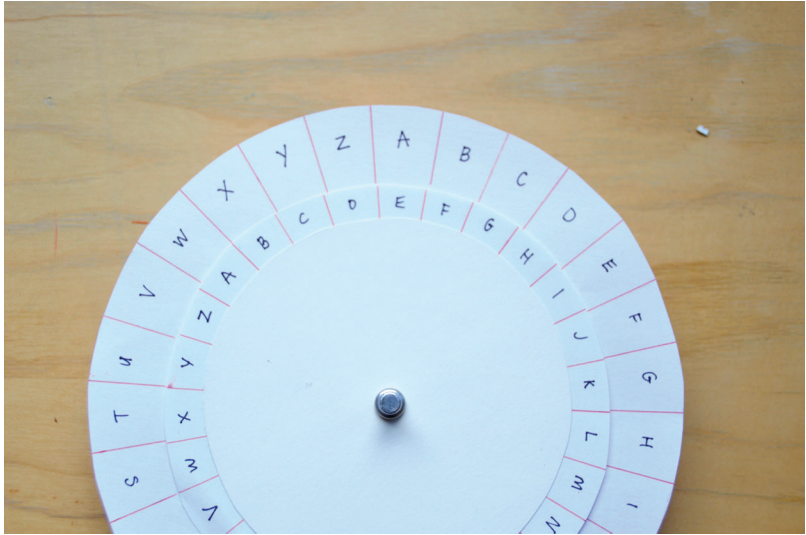
c. Invite the child to create their own coded messages, and then share them with friends or family members, remember, if we are going to share a secret, we both need to know how to decode the message with the shift number on our Caesar Cipher.
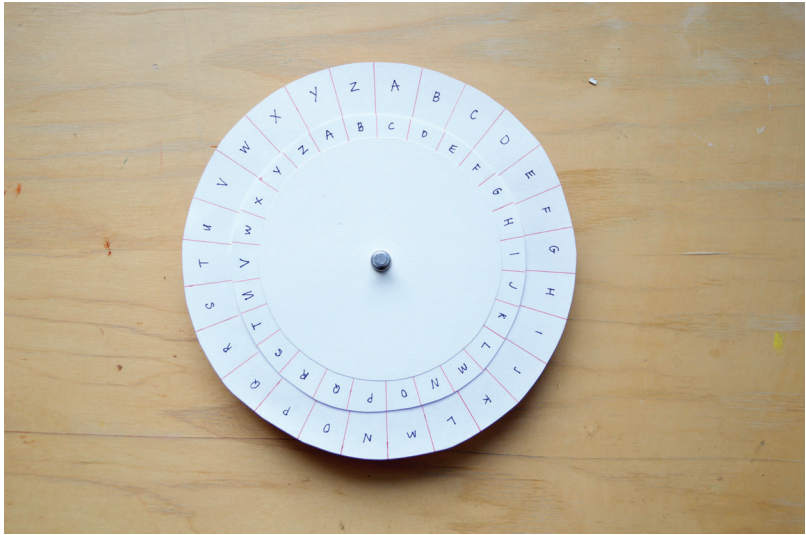
shift 2 places (to the left)
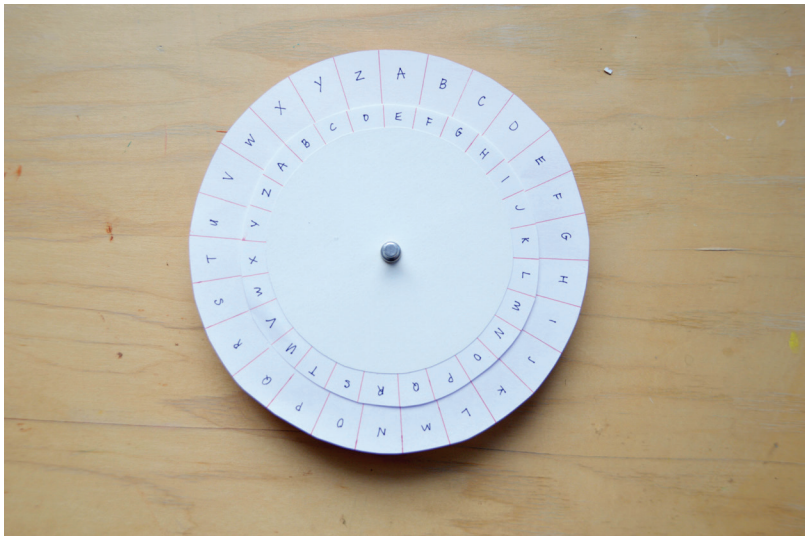

shift 4 places (to the left)

shift 4 places (to the left)

**If you don't have a printer, you can make your own:

a. Draw 2 circles, using something circular to trace around: one is large, and the other is smaller.

b. Cut them out.

c. Measure or fold them to find the midpoint.

d. Attach the circles at the midpoint (you can use a pin, this is the easiest, and then temporarily tape them together loosely with masking tape.

e. Using a compass or a protractor, measure 26 spaces around both of the circles (about 13.8 degrees)

f. And if you don't have a protractor, you can continue to cut the circle in halves so that you have 32 spaces (and fill the remaining spaces with numbers)

This is tricky! So it is helpful if you have a printer :)
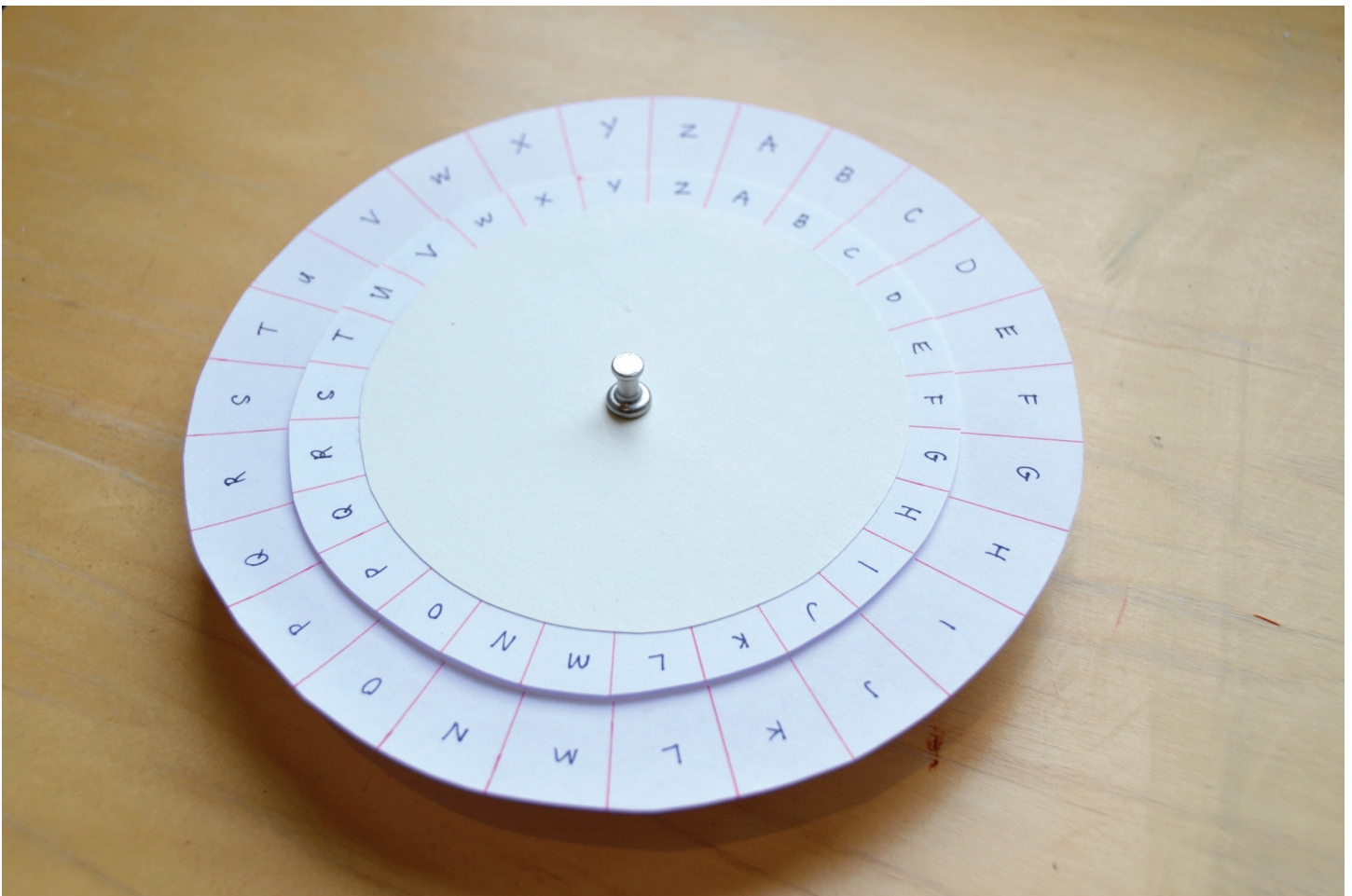
Activity 2: Book Ciphers

Overview
Book ciphers are really fun! We will use books to hide our secret messages - the book will contain words we want to share, and our encrypted message will be the location of the words inside the book. So long as the specific book remains a secret, no one will be able to understand our messages!

Objective
Children will understand how to use a book cipher to create messages. Children will understand that ciphers are a set of instructions for encrypting a message.

Ages: 4 - 13 years

Materials
-books
-paper
-pencil

Activity 2: Book Ciphers

1. Together find a book. This can be a simple children's book and it is most helpful if the pages are numbered. For this example, we have used *Where the Sidewalk Ends* by Shel Silverstein. In order to share secret codes with a book, both people need to have access to the same exact book (same edition as well).

2. Book ciphers use numbers to identify words on pages within the book. Our numbers will be locations of words inside the book.

For example, the numbers 11, 25, 4 would represent one word, and this word would be found on page 11, line 25, and 4 letters from the left. Note that both people have to agree on how we use these numbers.

3. Using your book, create a secret message...You can either create a secret message for you child, or invite the child to create messages and write the code. Each word for your message will be represented by three numbers: page number, line number, and the number of spaces from the left)

AND if you have Where the Sidewalk Ends, here is a message for you to crack! (We counted the titles are the first line.)

116, 2, 3

76, 8, 3

153, 11, 1

116, 13, 4

56, 5, 5

41, 5, 1

117, 5, 3