# Math Mysteries: Cracking Codes with Cryptography!

Hi Madison! Get ready to dive into the exciting world of secret messages and code-breaking. Today, we're going to become math detectives and explore cryptography!

## What is Cryptography?

Cryptography is the art and science of writing or solving codes. It's all about keeping information secret from those who aren't supposed to see it. From ancient spies to modern-day internet security, cryptography plays a huge role in our world!

# Warm-up: Your First Secret!

Let's start with a little challenge. Can you decode this message? The key is: each letter has been shifted forward by **3** places in the alphabet (A becomes D, B becomes E, etc.).

Secret Message: KHOOR WR PDWK!

(Scroll down for the answer when you think you've got it!)

# Activity 1: The Caesar Cipher - A Royal Secret

The cipher you just (hopefully!) cracked is called a Caesar Cipher, named after Julius Caesar, who used it to send secret military messages.

#### How it works:

- You pick a 'shift number' (like 3 in our warm-up).
- To encrypt a message, you shift each letter of your original message (plaintext) forward in the alphabet by that number of places. If you go past Z, you loop back to A.
- To decrypt a message, you shift each letter of the coded message (ciphertext) backward by the same number of places.

## Your Turn (Caesar Cipher):

- 1. **Encrypt:** Using a shift of **+5**, encrypt the message: "MATH IS FUN" (Write your answer on your Cipher Keys and Message Sheet.)
- Decrypt: Using a shift of -4 (or +22, which is the same!), decrypt the message: "QIBKYXAMKB LCSK"

(Write your answer on your Cipher Keys and Message Sheet.)

Think about it: What math are you using here? (Hint: Addition and subtraction!)

# **Activity 2: The Substitution Cipher - A Mixed-Up Message**

The Caesar cipher is fun, but pretty easy to crack if someone knows the method. A Substitution

Cipher is a bit trickier. In this cipher, each letter of the alphabet is systematically replaced by a different letter (or symbol).

#### How it works:

- You need a 'key' which shows how each letter is substituted. For example:
  - $\circ$  Plain: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
  - $\circ$  Cipher: Q W E R T Y U I O P A S D F G H J K L Z X C V B N M
- To encrypt, you find each letter of your plaintext in the 'Plain' row and replace it with the letter directly below it in the 'Cipher' row.
- To decrypt, you find each letter of your ciphertext in the 'Cipher' row and replace it with the letter directly above it in the 'Plain' row.

## Your Turn (Substitution Cipher):

Use the following substitution key for these tasks:

- Plain: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
- Cipher: X Z A B C D E F G H I J K L M N O P Q R S T U V W Y
- 1. Encrypt: "SECRET AGENT" (Write your answer on your Cipher Keys and Message Sheet.)
- Decrypt: "LCJJCM JXTCHR" (Write your answer on your Cipher Keys and Message Sheet.)

Think about it: What makes this harder to crack than a Caesar cipher? Could you still crack it without the key? (Hint: Think about how often certain letters appear in English words - like E, T, A, O, I, N.) This is called frequency analysis!

# **Activity 3: Create Your Own Cipher!**

Now it's time for you to be the cryptographer! Design your own unique cipher. Here are some ideas to get you started, but feel free to invent something completely new:

- A different shift for each letter? (Maybe based on a keyword?)
- Symbols instead of letters?
- A number-based cipher?
- A combination of ideas?

## Your Task:

- 1. Design your cipher. Write down the rules clearly so someone else could use it.
- 2. Give your cipher a cool name!
- 3. Write a short secret message (maybe 5-10 words) using your new cipher.
- 4. On a separate piece of paper (or the back of your sheet), write down the plaintext of your message and the rules for your cipher. This is your 'key'.

Be prepared to explain how your cipher works and challenge someone (maybe me later!) to crack it!

## **Discussion & Reflection**

Let's think about what we've learned:

- Which cipher was easier to use? Which was harder? Why?
- How could you make the Caesar cipher more secure?
- How does math (patterns, numbers, operations) help in creating and breaking codes?
- Can you think of any ways cryptography is used in your daily life? (Hint: Think about computers and the internet!)

## **Optional Extension Activities:**

- Research famous historical ciphers like the Vigenère cipher, the Enigma machine, or Pigpen cipher.
- Try some online cryptography puzzles or games (search for 'cryptography for kids' or 'cipher games').
- Think about how you could use a keyword to create a more complex substitution cipher.

#### Warm-up Answer: HELLO TO MATH!

Remember to keep your "Cipher Keys and Message Sheet" with all your encrypted and decrypted messages, plus your own cipher design!