Pringles Can Enigma

Put encryption/decryption in historical contexts through making your own mini Enigma machine

Grade Level(s)

3, 4, 5, 6, 7, 8, 9, 10, 11, 12

Cyber Connections

Threats & Vulnerabilities | Cybersecurity

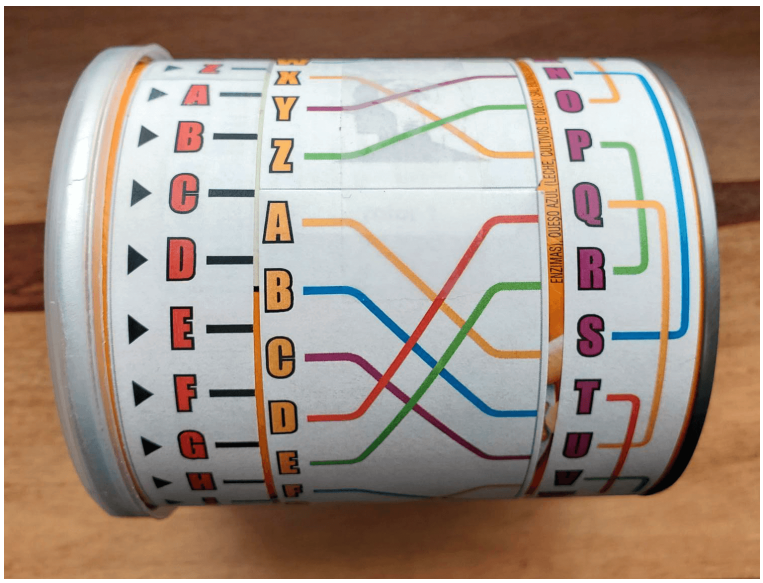
Materials

- Pringles Can
- Printed Paper Enigma (pg. 3)

  *NOTE: Print the page as actual size - **do not** select "Fit to Page"*
- Scissors

Construction

1. Cut each strip of paper along the thin gray outline of each strip.
2. Wrap each strip of paper around the Pringles can in the same order they were printed on the sheet.
3. Overlap the tab at the end of each strip and secure with a piece of tape.
4. Ensure each of the paper rings (rotors) can freely rotate.



Encryption

There are many start positions each rotor and the reflector can be set for. Align the rotors so all the A letters line up. Aligning the Input; Rotors 1, 2, 3; and the Reflector at Input position A is said to be set to A-A-A-A-A. Later, the start positions of each rotor will change, but for now leave them all aligned with A.

Starting from the left, locate the letter A on the input rotor. Follow the path from A on the input rotor to the letter A on Rotor 1. Follow the path from A on Rotor 1 to Rotor 2. The path leads to the letter C on Rotor 2. Now follow the path from C on Rotor 2 to Rotor 3. The path leads to the letter D on Rotor 3. Now follow the path from D on Rotor 3 to the Reflector. The path leads to the letter G on the Reflector. Follow the path from G on the Reflector to the output letter of the Reflector. The path leads to the letter L. Follow the paths back through each of the rotors. When you get to Rotor 1, the output letter should be L. This means that L is the encrypted letter A.

After you get an output letter, rotate Rotor 3 on letter "up". The rotors are now A-A-A-B-A. To encode our next letter, locate the letter C on the Input rotor. Trace it across rotors 1, 2, and 3, through the reflector and back through 3, 2, and 1. The output letter should be B.

Shift Rotor 3 "up" one time (because we got our output letter from before). The rotors are now A-A-A-C-A. Encode the letter E by finding it and tracing the path to and from the Reflector. The output letter should be V.

The word ACE when encrypted through this setup of the Enigma is LBV.

Decryption Activity

Because the message was encrypted with rotors in position A-A-A-A-A, it is important that the Enigma starts with that position. The first letter of the encrypted word is L. Trace the path from the Input rotor from L across Rotor 1 to M on Rotor 2, then to K on Rotor 3, and through L on the Reflector. On the Reflector, L reflects back to G, then to D on Rotor 3, then to C on Rotor 2, and finally to A on Rotor 1 which is aligned with A on our Input rotor. So the decrypted first letter is A.

Remember to shift the third rotor one step after each output letter. The next encrypted letter is B which follows the path D to F to B on the reflector, then out from D to G to E to C for the return path. The next decrypted letter is C.

Shift the third rotor once then trace the final letter, V, through the path. V connects to S to W to X on the reflector, then out from Z to C to B to E for the return path. The final decrypted letter is E.

Notice that the Input and Reflector do not rotate when encoding or decoding. Once those two are in position, they should remain in that position. When you turn the rotor next to the reflector, be sure the reflector has not accidentally turned also.

If your message is longer than 26 letters, you will have shifted Rotor 3 all the way around. Before you rotate back to A, shift Rotor 2 one time. After another 26 letters, Rotor 2 will turn once more. Rotor 3 will turn the most; Rotor 1 will turn the least. (For every 676 letters, Rotor 1 will turn 1 time!)

Rotor Settings

If all messages were sent with the same rotor settings (A-A-A-A-A), it would not be difficult to decrypt the message because everyone would have the same encryption mechanism. Designers of the original Enigma knew this and made it so you can set the rotors to whatever configuration you choose. As long as the recipient knows which rotor settings to use, you can decrypt the message.

Try this for practice:

Set the rotors to position C-Y-B-E-R . That means to align the letter Y on Rotor 1 with the C on the Input. Align the letter B on Rotor 2 with the Y on Rotor 1. Align the letter E on Rotor 3 with the B on Rotor 2. Align the R on the Reflector with the E on Rotor 3. This configuration is unique to these rotor settings.

Now, just as before, decode the following message and remember to turn Rotor 3 one step after each letter is encoded or decoded.

The message to decode is BVHFTD

The answer is the 2nd word of the 1st paragraph in the Background section. Did you get it?

If you answered that correctly, try the following Practice section for some more challenges.

Decryption Challenges

1

Rotor settings
A A A A A
Encrypted message:
I V W Y Q D V

2

Rotor settings
A A A A A
Encrypted message:
P V W Z A R C Y H R R C K W

3

Rotor settings
C Y B E R
Encrypted message:
Y P E L O N U P T O Z S

4

Rotor settings
C O D E S
Encrypted message:
h u f v e g z

5

Rotor settings
T U B E S
Encrypted message:
a c t r q i n x r n q l m v g

6

Rotor settings
R A D I O
Encrypted message:
y e d w p q b u b r j h w s e t l h d e n

Decrypted answers:

1. DECODED 2. SECRETxMESSAGE 3. CYBERxISxFUN 4. AMERICA 5. ExPLURIBUSxUNUM 6. WHATxHATHxGODxWROUGHT