

08

The Smallpeice Trust
ENGINEERING
@ SCHOOL

The Encryption Challenge

Subject: STEM/Engineering

Year group: 4-7



   #EngineeringAtSchool

ENCRYPTION CYPHERS TEACHER GUIDANCE

This activity can be used as one of eight towards students obtaining the CREST SuperStar Award.

What Is CREST?



CREST is a nationally recognised scheme for student-led project work in the STEM subjects (science, technology, engineering and maths).

CREST gives young people aged 5–19 the chance to choose their own subject and methodology when completing their hands-on investigation.

CREST provides activities and project ideas for a range of ages, group size and abilities. From off-the-shelf, one-hour long challenges through to large-scale, student-led projects of over 70 hours work or more, CREST can be done by anyone.

What is CREST SuperStar?

SuperStar level is designed to be easy-to-run and low-cost for children typically aged 7–11 years. Children gain an Award by completing eight challenges.

You can download a CREST SuperStar passport template for your students to track their progress once you create an account via

www.crestawards.org/crest-star

ENTRY FEE per child: £1 UK / £4 International*

Within four weeks of payment, you will receive certificates and fabric badges to give out to your class.

LENGTH OF LESSON: 1-2 HOURS

How to make your Encryption Cyphers:

<https://bit.ly/3fYR8pV>



LESSON OVERVIEW

Students work in teams of “engineers” to learn different methods of cryptography in order to encrypt and decrypt information.

Learning Objectives

During this lesson, students will:

- Design different methods of encryption
- Test and refine their methods
- Communicate their design process and results

Learning Outcomes

- To develop an understanding of encryption
- To develop an understanding of decryption
- To design and build models by using different materials and to test selected functional characteristics of the model built with the chosen materials

Key Vocabulary: ENCRYPT, DECRYPT, CYPHER, CRYPTOGRAPHY, CODE, ALGORITHM

Curriculum links

SCIENCE KEY STAGE 2

- Working scientifically: asking relevant questions and using different types of scientific enquiries to answer them
- Working scientifically: setting up simple practical enquiries, comparative and fair tests

DESIGN & TECHNOLOGY KEY STAGE 2

- Use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at individuals or groups
- Generate, develop, model and communicate their ideas through discussion, annotated sketches, cross-sectional and exploded diagrams, prototypes, pattern pieces and computer-aided design
- Select from and use a wider range of tools and equipment to perform practical tasks [for example, cutting, shaping, joining and finishing], accurately

INTRODUCTION

What is cryptography?

Explain to students that: Cryptography is the science of protecting information by transforming it into a secure format.

What is encryption?

Explain to students that: Encryption allows information to be hidden so that it cannot be read without special knowledge (such as a password). This is done with a secret code or cypher. The hidden information is said to be encrypted.

What is decryption?

Explain to students that: Decryption is a way to change encrypted information back into plain text.

What is a cypher?

Explain to students that: A cypher is an algorithm for performing encryption (coding) or decryption (decoding).

What is an algorithm?

Explain to students that: An algorithm is a detailed, step-by-step process followed in order to accomplish a specific task or to solve a specific problem.

Different methods of cryptography

INVISIBLE INK:

Explain to students that: Invisible ink is any substance that you can use to write a message that is invisible until the ink is revealed.

SUBSTITUTION CYPHER:

Explain to students that: In a substitution cipher, a rule is used to change each letter of the message, one at a time. The rule says to substitute each letter with another letter from the alphabet.

CAESAR CYPHER:

Explain to students that: In a Caesar cipher, every letter in the message is replaced with the letter that comes a certain number of places later in the alphabet.

Materials

1. LEMON JUICE
2. COTTON BUDS
3. PAPER
4. IRON (AND IRONING BOARD)

1. PEN/PENCIL
2. PAPER

1. PENCIL
2. FELT TIPS
3. CARDBOARD
4. SCISSORS
5. PAPERCLIP
6. CD/SELLOTAPE TO TRACE

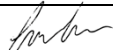
MAIN ACTIVITY

- 1 Students will need to work in pairs for this activity.
- 2 Explain that students must develop different methods of cryptography from everyday items.
- 3 Ask students to develop a plan for different cryptography methods. They will need to decide and agree on the materials they will use, write/draw their plan, and present their plan to the class.
- 4 Show students the student activity sheet and explain that they will need to follow the instructions to make their different cyphers.
- 5 Student groups build their cypher using the materials they have chosen. They may need to rethink their plan, request other materials, or start again if the materials chosen are not working.
- 6 Next, teams will test their methods on different students.
- 7 Teams complete an evaluation / reflection worksheet, and present to the class.

PLENARY (QUESTIONS TO ASK STUDENTS)

1. Did you succeed in encrypting information?
2. Which materials did you use for your cypher?
3. What cryptography methods were you able to complete?
4. Did you decide to request additional materials while in the construction phase? Why?
5. If you could have had access to materials that were different than those provided, what would your team have requested? Why?

STEM Day Risk Assessment

Risk Assessment for	Engineering at School Projects
Assessment undertaken on	31/03/2020
Assessment undertaken by	Jessica Lee
Signed	

No.	Activity/area being assessed	Associated risk	Who is at risk?	Existing control measures in place?	Level of risk (low, medium, high)	Responsibility
1	General Activity and Workspace	Slips, trips and falls: Injury due to tripping over items	Students and adults	Activity supervised by adult supervisor. Deliverer reminds students about safety in video introduction.	M	Students and adults
2	Use of Materials: paper/card, plastic containers	Injuries: Injury due to paper cuts, cuts from sharp edges Injuries: Injury due to misuse	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
3	Use of materials: elastic bands, sellotape, glue stick, blu-tack, small toys, paper fasteners, LEGO pieces, nuts & bolts or equivalent.	Injuries: Injury due to use as a missile Slips, trips and falls: Injury due to slipping on dropped items Injuries: Ingestion risk of choking.	Students and adults Students and adults Students and adults	Activity supervised by adult supervisor. Activity supervised by adult supervisor. Activity supervised by adult supervisor.	L	Students and adults
4	Use of materials: plastic, corrugated cardboard	Injuries: Cuts from sharp edges	Students and adults	Activity supervised by adult supervisor.	L	Students and adults

No.	Activity/area being assessed	Associated risk	Who is at risk?	Existing control measures in place?	Level of risk (low, medium, high)	Responsibility
5	Use of sharp tools: Scissors, craft knives	Injuries: Cut to self Behaviour: Cut to others Behaviour: Vandalism of property	Students Students and adults School or home	Activity supervised by adult supervisor. Activity supervised by adult supervisor. Activity supervised by adult supervisor.	M L L	Students and adults Students and adults Students and adults
6	Testing of projects: bathtub, drop from height, items on floor	Spillage of water on floor: damage and injury due to slip Slip, trip or fall: Injury due to falling from testing area, tripping over items in testing space	Students and adults Students and adults	Activity supervised by adult supervisor. Activity supervised by adult supervisor.	L L	Students and adults Students and adults

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The
Encryption
Challenge

#EngineeringAtSchool

Suitable
for ages:

7+

Time
needed:

1hr+



smallpeice
Dare to imagine



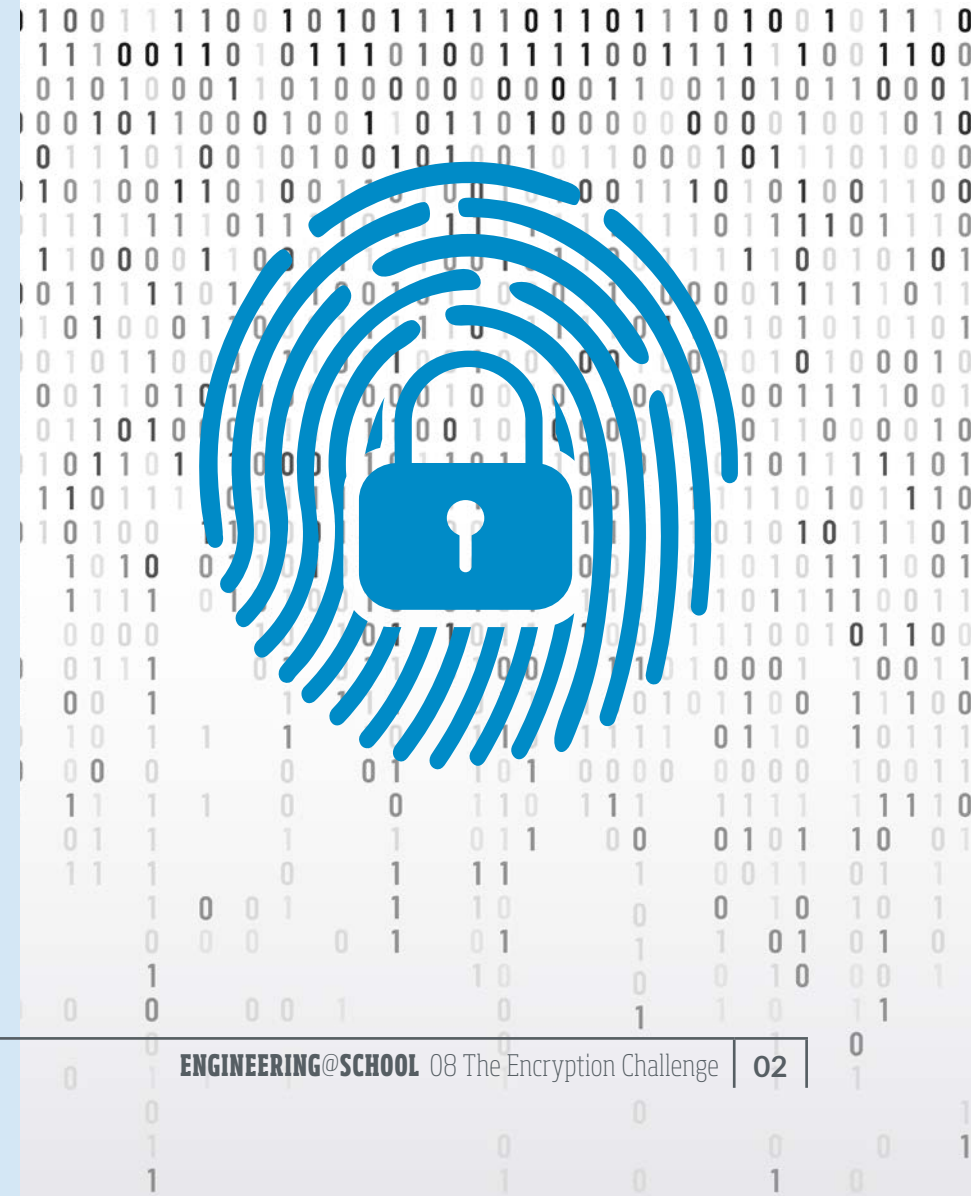
CREATE DIFFERENT METHODS OF CRYPTOGRAPHY

You are a team of engineers who have been given the challenge to create different methods of cryptography out of everyday items.



What is cryptography?

Cryptography is the science of protecting information by transforming it into a secure format.



Activity 01

Invisible Ink

WHAT MATERIALS TO USE

You can use anything you can find at home.

Try looking in your recycling box.

HERE'S WHAT WE USED:

1. LEMON JUICE
2. COTTON BUDS
3. PAPER
4. IRON (AND IRONING BOARD)



Activity 01

Invisible Ink

INSTRUCTIONS

- 1 Pour plenty of lemon juice into a bowl or egg cup.
- 2 Dip your cotton bud into the lemon juice, making sure it's got plenty on.
- 3 Write your message in lemon juice on a plain piece of paper.
- 4 Leave your message to completely dry out.
- 5 **WITH ADULT SUPERVISION** turn your iron onto maximum heat (make sure steam settings are off) and heat your message using the iron.
- 6 Read your secret message!



Activity 02

Substitution Cypher

WHAT MATERIALS TO USE

You can use anything you can find at home.

Try looking in your recycling box.

HERE'S WHAT WE USED:

1. PEN/PENCIL
2. PAPER



Activity 02

Substitution Cypher

INSTRUCTIONS

- 1 Write out the alphabet A-Z with some space underneath
- 2 Underneath each letter place a number, counting up from 1 to 26.

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
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

- 3 Solve the message below using this code...

MESSAGE ONE

▶ 3 1 14 25 15 21 19 15 12 22 5 20 8 9 19 3 15 4 5?

Activity 02

Substitution Cypher

4 Solve these messages, but beware the code changes for each message!

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
3	6		12	15	18			27	30			39	42		48	51	54	57		63	66	69	72		

MESSAGE TWO

▶ 69 24 3 60 3 6 45 63 60 60 24 27 57 24 3 54 12 15 54 45 42 15?

.....

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
200	195	190			175	170	165	160		150				130	125	120	115								

MESSAGE THREE

▶ 165 130 90 200 195 130 100 105 135 130 90?

.....

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
28		62	79		113	130	147		181		215	232	249	266		300		334			385	402	419		

MESSAGE FOUR

▶ 62 266 249 130 317 28 351 368 215 28 351 164 266 249 334
436 266 368 334 266 215 385 96 79 351 147 96 232 28 215 215

.....

Activity 03

Caesar Cypher

WHAT MATERIALS TO USE

You can use anything you can find at home.

Try looking in your recycling box.

HERE'S WHAT WE USED:

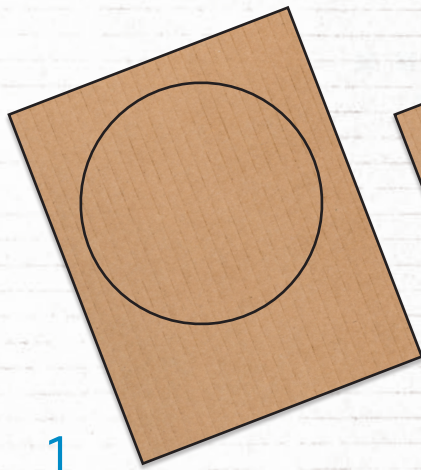
1. PENCIL
2. FELT TIPS
3. CARDBOARD
4. SCISSORS
5. PAPERCLIP
6. CD/SELLOTAPE TO TRACE



Activity 03

Caesar Cypher

INSTRUCTIONS



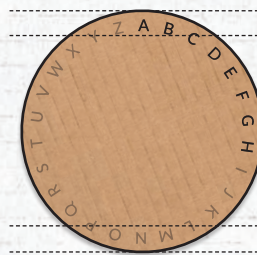
1.

Draw a large circle on a piece of cardboard. You can trace around a CD (or a mug or anything else to make a large circle).



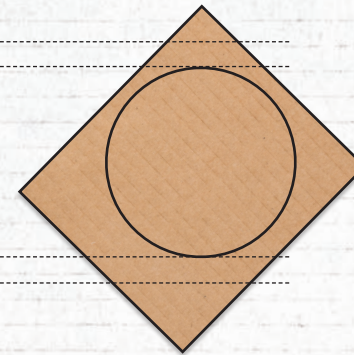
2.

Cut out the large circle or make one large cardboard disc.



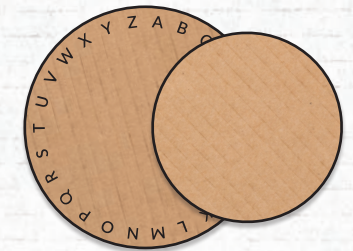
3.

Write the alphabet out evenly along the outside of this large disc.



4.

Draw a smaller circle on cardboard (this must fit inside the alphabet so check its size).



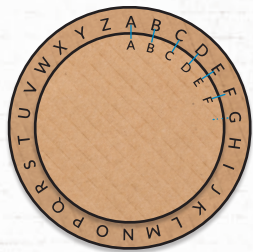
5.

Cut out the smaller circle and put on top of the large disc.

Activity 03

Caesar Cypher

INSTRUCTIONS



6.

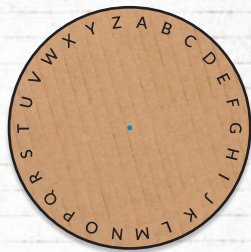
Write the alphabet out again on the small disc making sure the letters line up.

If you have access to a printer you can print the next page of the handout and stick this to your discs.



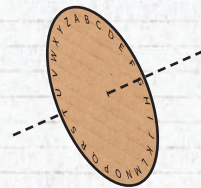
7.

Find the middle of both discs and mark a small dot.



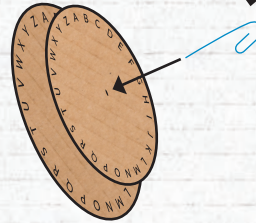
8.

Carefully use a paperclip or scissors to punch a small hole in the exact centre of both discs.



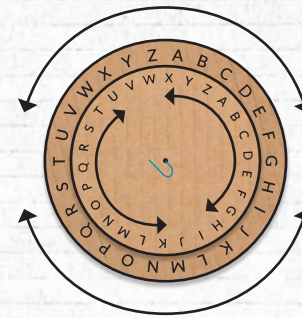
9.

Join both discs together using a paperclip or paper fastener.



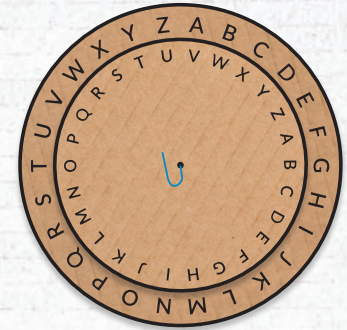
10.

Make sure both discs can spin freely, you may need to make the hole larger if it does not spin.



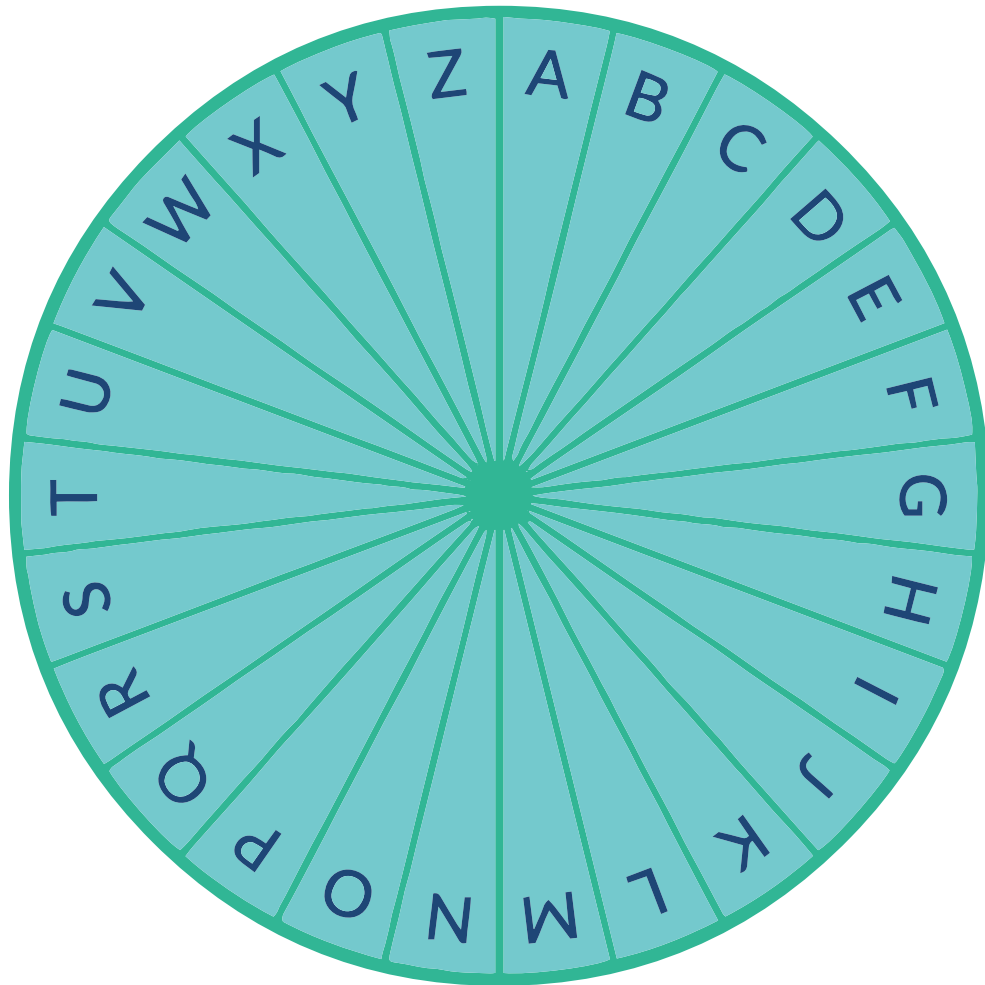
11.

USE YOUR CAESAR WHEEL TO WRITE/ SOLVE A CAESAR CYPHER!



H = C
E = Z
L = G
L = G
O = J

CZGGJ



TESTING STAGE

Each team will test their encrypted messages in their pairs.

ENCRYPTED MESSAGES DATA

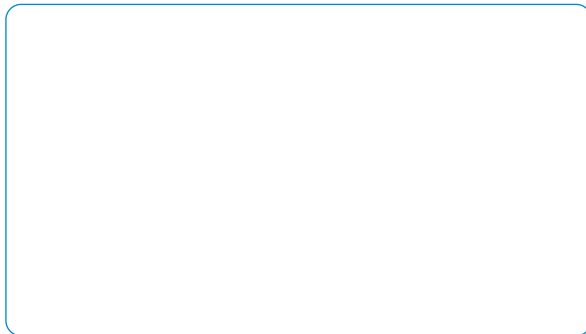
	Student One	Student Two
Test 1 Substitution Cypher	MESSAGE:	MESSAGE:
Test 2 Caesar Wheel	MESSAGE:	MESSAGE:

EVALUATION STAGE

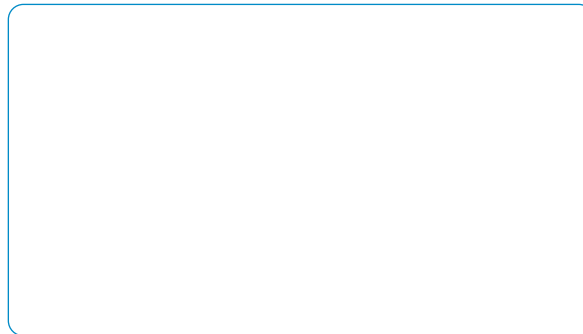
Evaluate your team's results, complete the evaluation worksheet, and present your findings to the class.

Use this worksheet to evaluate your team's results in the Encryption Challenge.

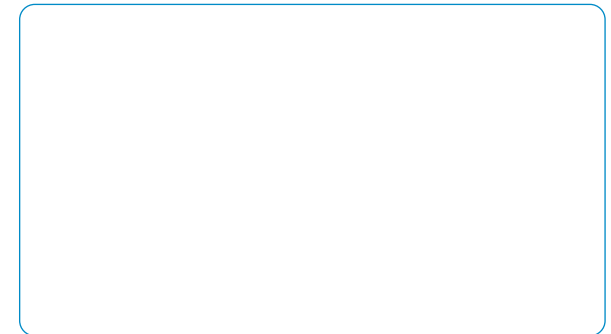
1. Did you succeed in encrypting information?



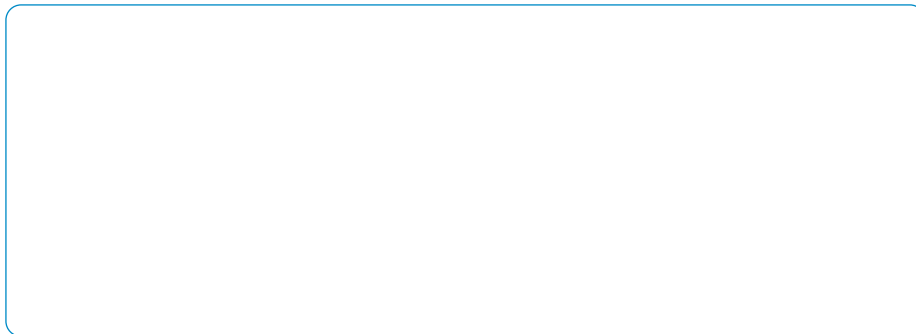
2. Which materials did you use for your cypher?



3. What cryptography methods were you able to create?



4. Did you decide to revise your original design or request additional materials while in the construction phase? Why?



5. If you could have had access to materials that were different than those provided, what would your team have requested? Why?

