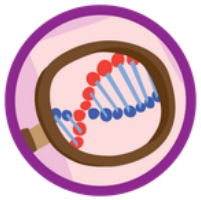
girl scouts of wisconsin badgerland

Senses



Detective

Special Agent

Investigation Multi-Level Badge Series

Investigation Series: Badge Requirements

There are two pathways that you can follow in this booklet to satisfy the requirements for Brownie, Junior, and Cadette levels at the same time: Spies in Training or Crime Scene Investigators. If you'd like to pick and choose your own activities, you can see the individual level requirements on the next page.

Spies in Training

Required:

- Observation Station
- Types of Evidence
  - Fingerprints
  - Ciphers
  - Handwriting
  - Body Language
  - Chromatography
  - Impressions
- Design a Disguise
- Escape Room, Solve a Case, or Mystery Game

Crime Scene Investigators

Required:

- Observation Station
- Evidence Collection
- Types of Evidence
  - Fingerprints
  - Invisible Ink
  - Microscopes
  - DNA Fingerprinting
  - Voice Analysis
- Escape Room, Solve a Case, or Mystery Game

Investigation Series: Badge Requirements

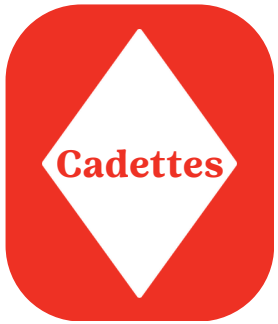
This Badge in a Booklet includes the Brownie, Junior, and Cadette Investigation Badges. If you'd like to pick and choose activities from the kit, these are the required activities for each level.

Required:

- Observation Station:
  - Kim's Game
  - Sound
  - Smell
  - Taste
  - Touch

Required:

- Observation Station:
  - Kim's Game
- Types of Evidence:
  - Fingerprints
  - Invisible Ink OR Ciphers
  - Handwriting, Microscopes, OR DNA fingerprinting
- Solve a Case OR Escape Room



Required:

- Types of Evidence:
  - Impressions
  - DNA fingerprinting OR Chromatography
  - Body Language or Voice Analysis
- Evidence Collection OR Design a Disguise
- Solve a Case OR Escape Room

General Supplies:

- paper, pencils, pens, markers
- 30 random objects for Kim's game, hearing game
- opaque container like film cannisters
- magnifying glasses or microscope
- invisible ink pen/UV light or lemon juice and heat
- ink/fingerprinting pad
- corn starch, cocoa powder, tape, brush
- chromatography paper (coffee filters or thick paper towels work, but the pattern is harder to see)
- water, cups
- ruler
- modeling clay
- clay tools
-

Escape Room/Crime Scene Alternatives

- Escape room style board games
- Clue
- Junior Detective board game
- Visit a local escape room

Observation Station

Look: Kim's Game

Play the spy training game: Kim's Game.

What you need to supply:

- an assortment of 30 different objects or picture of objects

Observation Station: Look

READ

Kim's Game is a memory game that will help sharpen your observational skills and help you become better at paying attention to details. The game can be played in many different ways. Sometimes, people will use the items that are already in a room and then have everyone else close their eyes. They'll remove an item and then everyone else will have to figure out what item was removed.

Another way to play the game is to have a group of about 30 different items on the table and everyone gets 30 seconds to memorize the items. Then they have to write down every object they remember without looking at the objects again and see who can remember the most.

THINK

Do you have any memory tricks that you use in school or at home?

DO

For this version of Kim's game, a troop volunteer or older Girl Scout will set out about 30 objects on a table. You'll get 30 seconds to memorize as many objects as you can. Then everyone will turn around and the volunteer or older Girl Scout will take one object away. When you turn back, you will have to guess which object is gone!

For older Girl Scouts or those needing more of a challenge, instead of guessing which object is gone, you can try to make a list of as many of the items as you can remember before turning around. Whoever lists the most objects, wins!

Observation Station

Listen: Sound Boxes

Guess an object by their sound.

What you need to supply:

- small opaque boxes, containers or black film canisters
- a variety of materials that fit inside the containers (rice, coins, etc)

Observation Station: Listen

READ

Sound is created by something making a vibration. When we're talking, we move air past our vocal chords in our throat and make different sounds based on how much air we push past the vocal cords and how fast we're pushing it. This causes different sound vibrations and makes our voices sound different.

We hear that sound when the vibrations reach our ear drum and that sends a signal to our brain which helps us figure out what the sound is. If your eardrum is tight because of an ear infection behind it, everything might sound muffled or harder to hear.

THINK

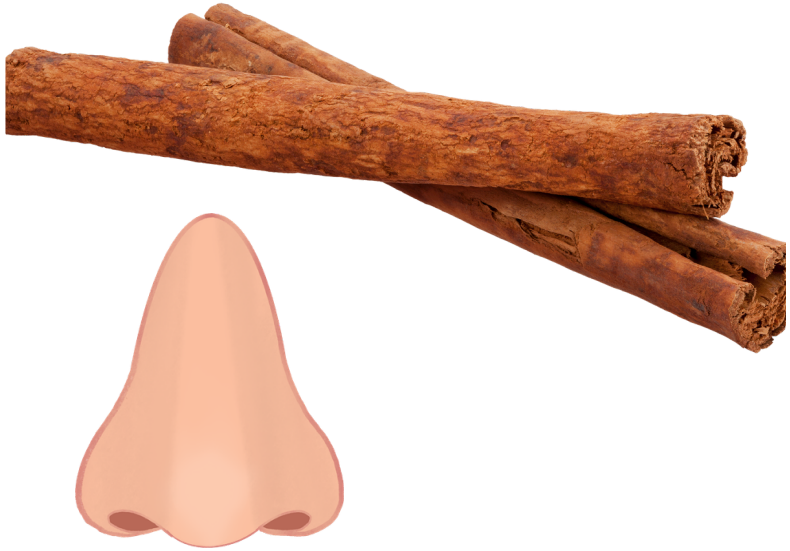
Think of a musical instrument or two. How do you think the instrument makes vibrations to make sound?

DO

You will work with a partner. The first person will choose an object from the sound table and put it in a container. The second person will shake the container and see if they can figure out which object is inside. They can also try listening with their eyes closed to see if that changes the sound. They will take a guess about which object they think is insde.

Then they will switch roles and do the sound guessing game again. You can continue taking turns until it is time to switch stations.

Observation Station



Smell: Scent Trails

Follow a scent trail.

What you need to supply:

- lemon slices, cinnamon sticks, or something else with a strong scent
- optional blindfolds

Observation Station: Smell

READ

You use your nose to smell different foods and chemicals. Inside of your nose, there are tiny receptors that receive the smells and send those signals up to your brain. Your brain uses that information along with the things you are seeing and tasting to figure out what the smell is. Some foods or chemicals have really strong smells and others barely smell at all.

Every person is unique and might like a smell that someone else dislikes. The human nose can smell up to 10,000 different smells, but because not everyone's nose is the same, some people don't smell as many as others.

THINK

Do you have any favorite smells? Maybe a specific smell that makes you think of a memory?

DO

You will work with a partner. The first person will close their eyes and not peek. The second person will put an item with a strong scent near the first person's nose and then slowly walk away. The person with their eyes closed will try to follow the path of the scent.

After you've reach the end point or your time is up, then you will switch roles and the other person will give it a try.

Observation Station

Taste: Taste Buds

Learn about taste buds.

What you need to supply:

- magnifying glasses
- optional: super-taster test strips; variety of foods for tasting or candies like skittles with a variety of flavors

Observation Station: Taste

READ

You use your tongue to taste different foods and liquids. On top of your tongue where it looks bumpy, those little dots are called taste buds. The scientific name for tastebuds is fungiform papillae. These taste buds help us taste different flavors of food. The main flavors of food are: sweet, salty, sour, bitter and savory. Sweet flavors are things like chocolate, fruit, candy, and things with sugar. Salty flavors have a lot of salt in or on them, like popcorn or chips. Sour flavors are things that make your mouth pucker like lemon or vinegar. Bitter flavors can be found in things like coffee or brocolli. Savory flavors are things like meat, mushrooms, some vegetables, and cheeses. Some people have more taste buds than others or can taste flavors other people can't.

THINK

Do you have a favorite type of food or snack? Which flavor or flavors does it fit under?

DO

You will work with a partner. Use a magnifying glass to take turns looking at each other's tongues. Be careful, DO NOT TOUCH the magnifying glass to the tongue.

Can you see the other person's taste buds? Do they have a lot of them close together or are they pretty spread out? Where are their taste buds? Are their the same amount at the front of the mouth as their are towards the back?

If a person has a lot of tastebuds close together, is picky about flavors and doesn't like bitter flavors, they might be a supertaster! There are even test strips you can buy to test if you are a supertaster.

You can test out how your sense of smell affects your senses by eating Skittles or other flavored foods with your eyes closed and your nose pinched. Start chewing and guess which flavor it is; then let go of your nose and see if that makes it easier to figure out which flavor it was!

Observation Station

Touch: Braille

Learn about Braille and figure out a word written in Braille.

What you need to supply:

- printed copies of the braille alphabet
- a secret word written in braille

Observation Station: Touch

READ

When we touch and feel something with our hands we can feel different textures like smooth, rough, bumpy, hard, squishy, sticky, or hairy.

We can feel with other parts of our body besides just our hands. Our skin can sense pressure like something pushing on our arm. It can also sense temperatures like when you wash your hands with hot or cold water. Your skin is also covered in many places with tiny hairs. These hairs can help your skin sense when something is near you, if a tiny bug lands on you, or if a person is passing by you closely. The hairs move around when the air whooshes past them and your skin senses the hair moving.

THINK

What types of textures do you like to feel or not feel?

DO

When a person is blind or has trouble with their sense of sight, instead of reading with their eyes, they might learn to read with their sense of touch instead.

Braille is made up of bumps placed in different spots to represent each letter of the alphabet. Instead of looking at a word and seeing the letter A, a blind person could feel the page and figure out the letters based on where each of the bumps or dots are at.

You may have seen Braille next to room numbers in some schools or buildings or in an elevator under the numbers. See if you can use the Braille code to figure out what the secret word is!

Braille Alphabet

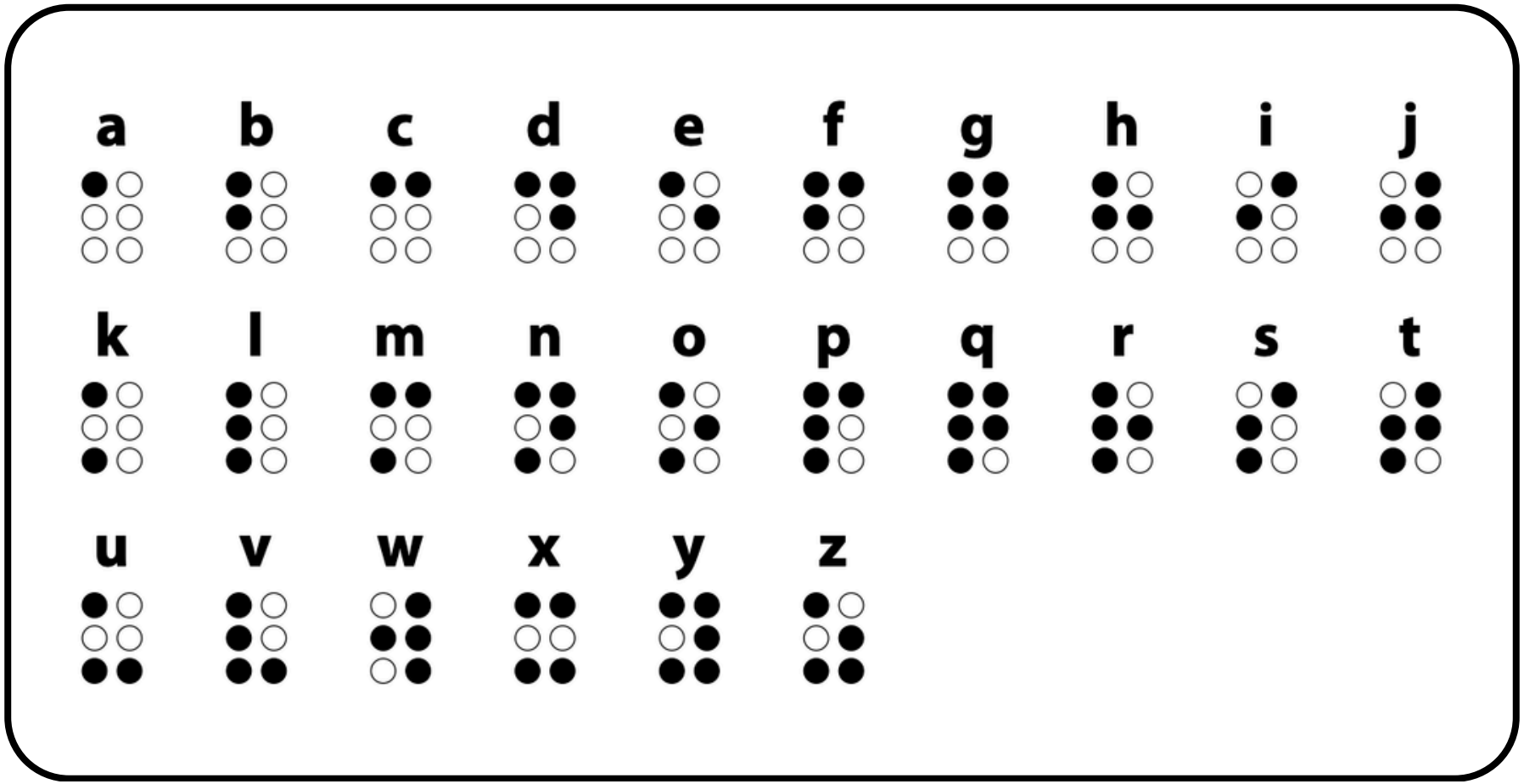


Image from: https://www.pathstoliteracy.org/braille-sighted-classmates-and-family-members/

Invisible Ink

Create secret messages using invisible ink

What you need to supply:

- paper, a disappearing ink pen and a UV flashlight

If you would like to try the other invisible ink methods, you will need:

- baking soda, water, cups, grape juice, q-tips
- lemon juice, q-tips, a heat source
- tonic water

Types of Evidence: Invisible Ink

READ

Invisible ink has been used to deliver secret messages for over 2,000 years! Spies would use different types of invisible ink so that if someone else found their message, they wouldn't be able to read it or might not even know that it was there! There are different types of invisible ink that you can use. If you write with lemon juice and let it dry, then you would need to use heat or fire to help the writing appear. If you write with baking soda to create your invisible message, then you would use an acid like grape juice to show the message.

During the Revolutionary War, spies would include an F (fire) or an A (acid) on the message, so that way the person who got the message would know how to make it appear.

THINK

Why do you think spies would use many different types of invisible inks for different messages?

DO

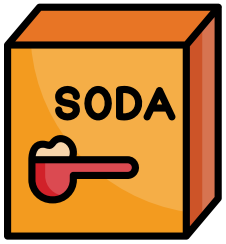
You will be creating your own secret message using invisible ink and then a partner will try to reveal the message. You will use the supplies provided by your troop to write your message for one or more of these invisible ink methods:

Lemon Juice--> message revealed by heat or fire (F)
Baking Soda--> message revealed by grape juice which is an acid (A)
Tonic water or a special pen with flourescent ink--> message revealed by UV light (U)

Invisible Ink: Baking Soda and Grape Juice (acid)

Supplies:

- Baking Soda
- Water
- Cups
- paper
- toothpics
- Q-tips
- Grape juice or another dark colored juice



Step 1: Mix ¼ cup of baking soda with ¼ cup of water

Step 2: Write your baking soda solution message with a Q-tip or toothpick

Step 3: Let your message dry all the way

Step 4: Dip a Q-tip into grape juice or another dark colored juice and then gently swipe it over the paper to reveal the message. You want to use just enough juice to develop the message, but not too much to wash it away.

Invisible Ink: Lemon Juice and heat (fire)

Supplies:

- lemon juice
- Q-tips
- paper
- heat source: hair dryer, heat gun, candle, or incandescent lamp

Step 1: Dip a Q-tip into the lemon juice and use it to write a message on the paper

Step 2: Let your message dry all the way

Step 3: Use a heat source to warm up the paper and reveal the message. Be careful not to get the paper too close to an open flame or the heat source. You don't want it to light on fire!

Invisible Ink: UV messages

Supplies:

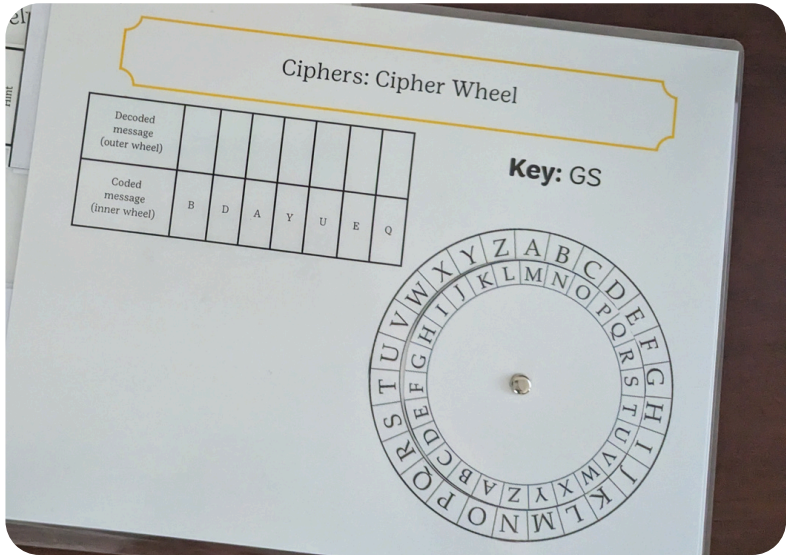
- fluorescent marker or tonic water and Q-tip
- UV flashlight

Step 1: Write a special invisible ink marker or pen that contains flourescent ink.

OR

Dip a Q-tip into the tonic water and use it to write a message on the paper and let your message dry all the way.

Step 3: Use a UV flashlight to reveal the message



Ciphers

Create secret messages using ciphers

Things to get ready ahead of time

- You will need to print and cut out the decoder wheels so that they can be assembled with a brass fastener.
- If you'd like to use the Hint Cards and Answer Cards, you will want to print and cut those out ahead of time. Consider putting the hint and answer cards in envelopes or flipping them over and writing HINT and ANSWER on the back.
- For the single letter and picture grilles, you will need to cut out the black rectangles and green trefoil on the grille cards that say "needs to be cut"

Types of Evidence: Ciphers

READ

A cipher is a code that spies use to hide their message. If someone intercepts or gets the message when they aren't supposed to have it, a cypher could make the message look like jumbled letters, numbers, or symbols. Other ciphers might hide a small message inside of the longer message by using every 12th word, or only using the first word of each line, or something similar.

THINK

Have you ever created your own code or secret message before? If so, how did it work? If not, think about how you could create your own code.

DO

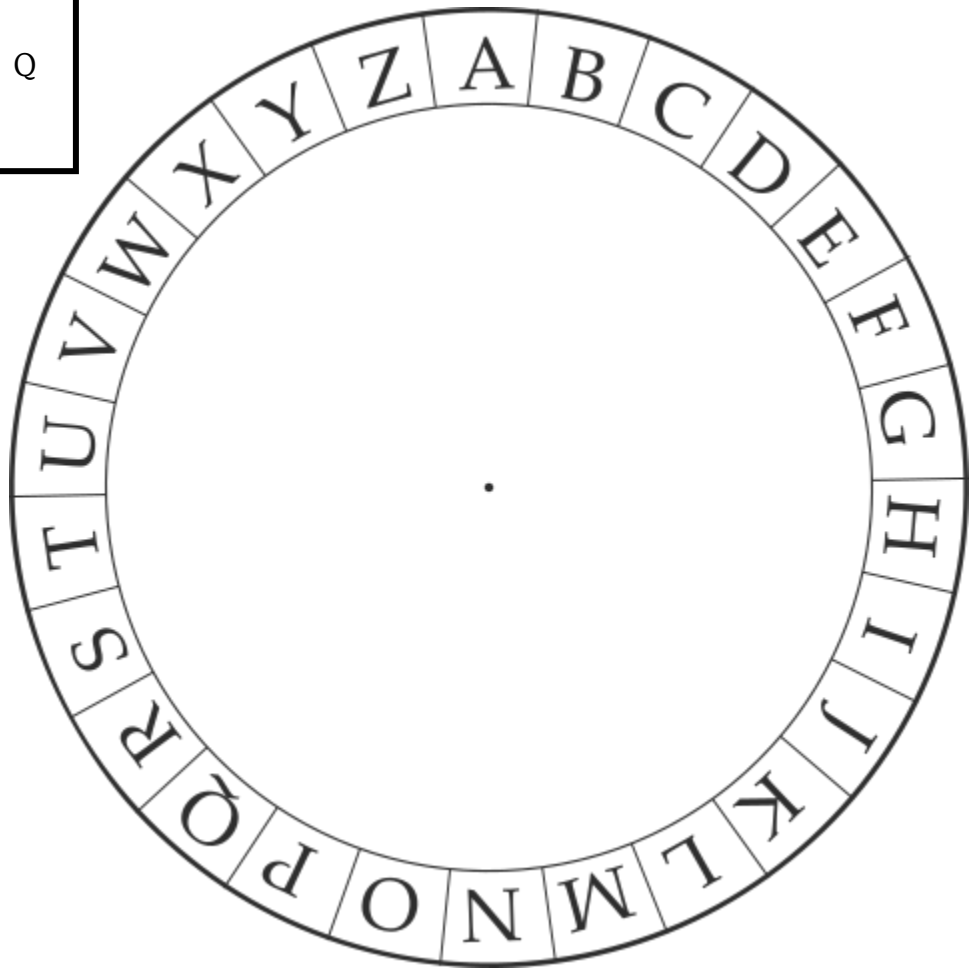
When you're passing a ciphered message back and forth between two people, they usually both know what type of cipher it is and how to decode it. If you don't know how to decode the message, it will take you much longer to crack the code, or you may not be able to ever figure it out at all.

You will try to decode different messages that were created using different types of ciphers. Each message has the decoder with it. See if you can figure out each of the messages. If you can't figure out the decoder, you can use the hint for instructions on how to use the decoder.

Ciphers: Cipher Wheel

Decoded message (outer wheel)							
Coded message (inner wheel)	B	D	A	Y	U	E	Q

Key: GS

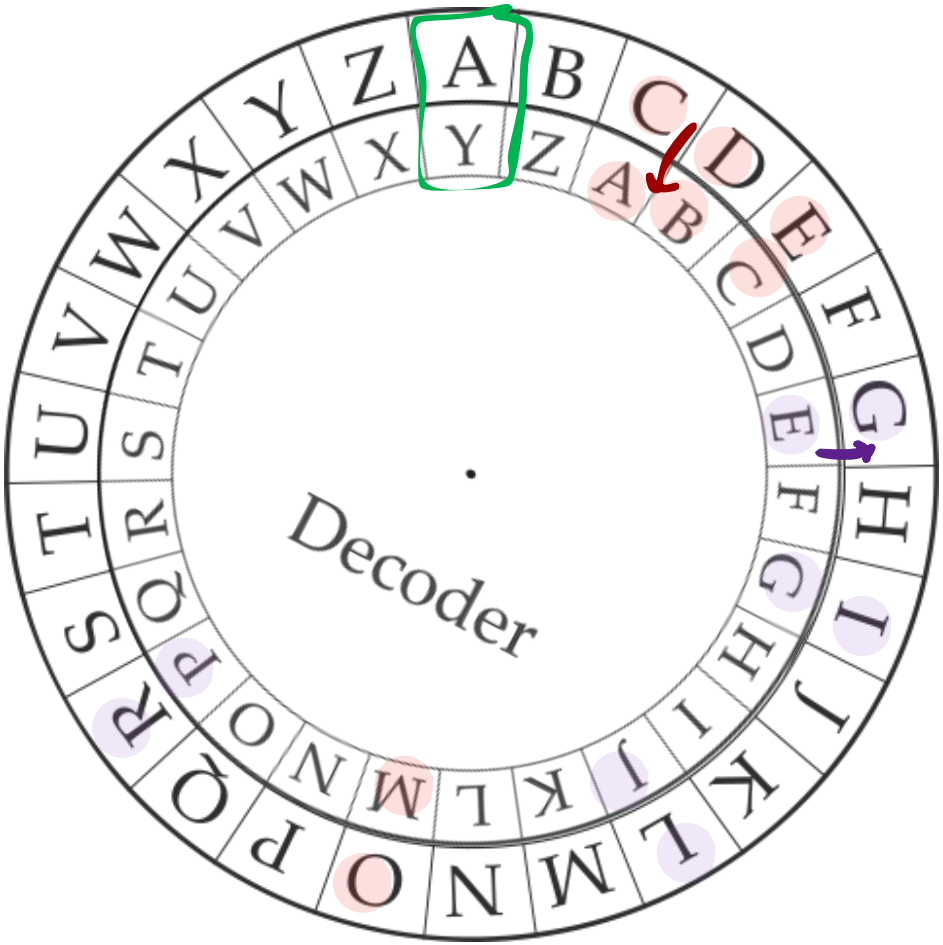


Decoder Wheel Printable

girl scouts of wisconsin badgerland

Cipher Wheel Example

Key: AY



Line the letters in the **Key** up.

To write a message: you find the letters in your word on the outside wheel and code them into the letter that matches up on inside wheel. So the word CODE would become AMBC.

To decode a message, you have to work backwards. The coded letters start on the inner wheel and then you have to work backwards to the outer wheel to figure out what the message was. In this examples, E would become G. So the coded message EGPJ works backwards to become the word GIRL

Ciphers: Cipher Wheel Hint

Hint

Hint:

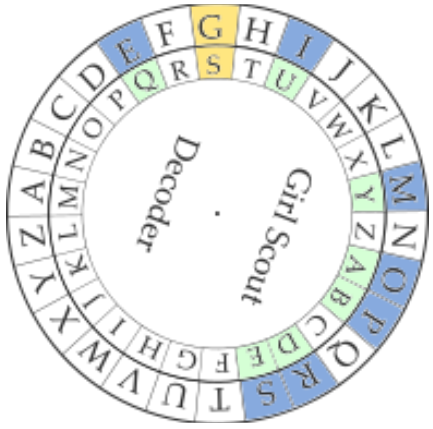
The key for this decoder is GS for Girl Scouts. That means that you will turn the wheel so that the outside wheel's G is aligned with the inside wheel's S.

If you get stuck after this, ask yourself: what worked? what didn't work? what can you do differently?

Answer

Answer:

PROMISE



Ciphers: Caeser (shift cipher)

Decoder Key: 3-->

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

secret message	R	Q		P	B		K	R	Q	R	U

Ciphers: Shift Hint and Answer Card

Hint

Hint:

You will shift the alphabet by 3 spaces. So the code will be A-->X

B-->Y

C-->Z

D-->A

and so on.

Answer

Answer:

On My Honor

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

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

Ciphers: Numeral

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

secret message	7	9	18	12		19	3	15	21	20		12	1	23

Ciphers: Numeral Hint and Answer Card

Hint

Hint:

Each number represents a letter.

What do you think the number 1 stands for?

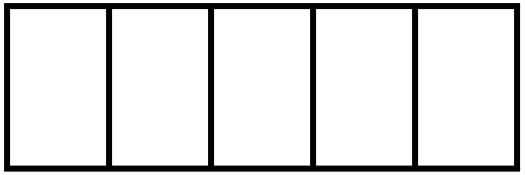
Answer

Answer:

Girl Scout Law

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

Ciphers: Single Letter Grille



Girl Scout Promise

On my honor, I will try:
To serve God* and my country,
To help people at all times,
And to live by the Girl Scout Law.

*Members may substitute for the word God

in accordance with their own spiritual beliefs.

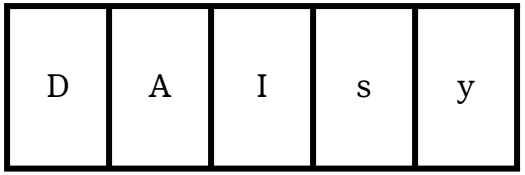
Girl Scout Law

I will do my best to be
honest and fair,
friendly and helpful,
considerate and caring,
courageous and strong,
and responsible for what I say and do,
and to respect myself and others,
respect authority,
use resources wisely,
make the world a better place,
and be a sister to every Girl Scout.

Ciphers: Single Letter Grille Card

(Needs to be cut)

Ciphers: Single Letter Grille Answer Key



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and responsible for what I say and do,
and to respect myself and others,
respect authority,
use resources wisely,
make the world a better place,
and be a sister to every Girl Scout.

Ciphers: Picture Grille

Have you ever heard about Girl Scouts before?

Girl Scouts make the best cookies!

They are out of this world and

there's no better place to buy cookies!

Ciphers: Picture Grille Card

(needs to be cut)

Ciphers: Grille

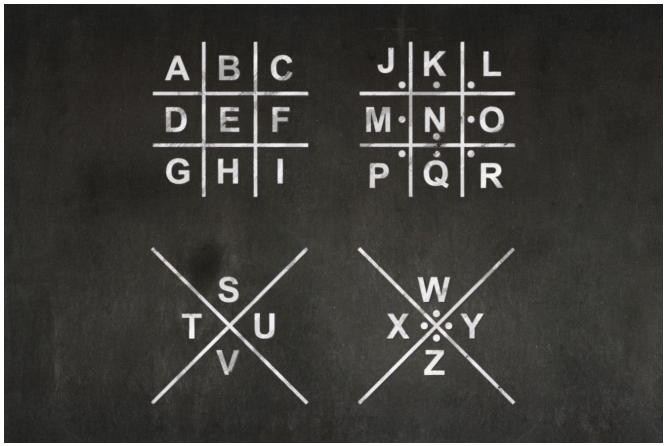
Answer

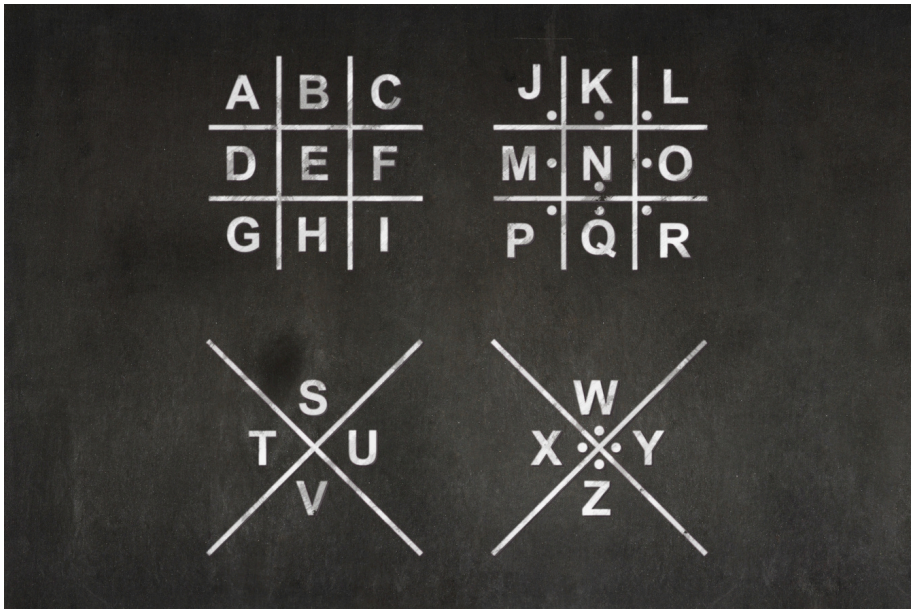
Answer:

Girl Scouts make the world a better place

Ciphers: Pigpen

secret message						




A B C
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X Y
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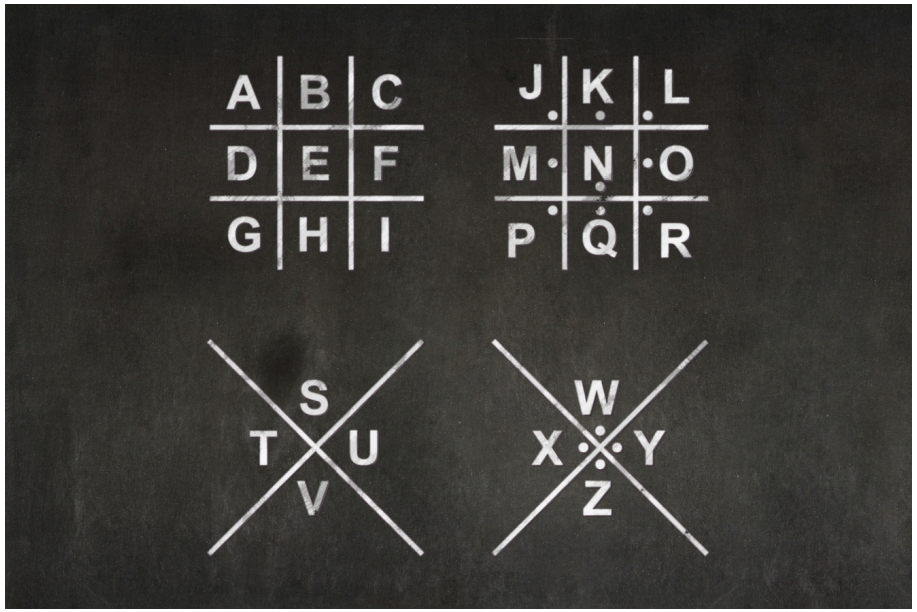
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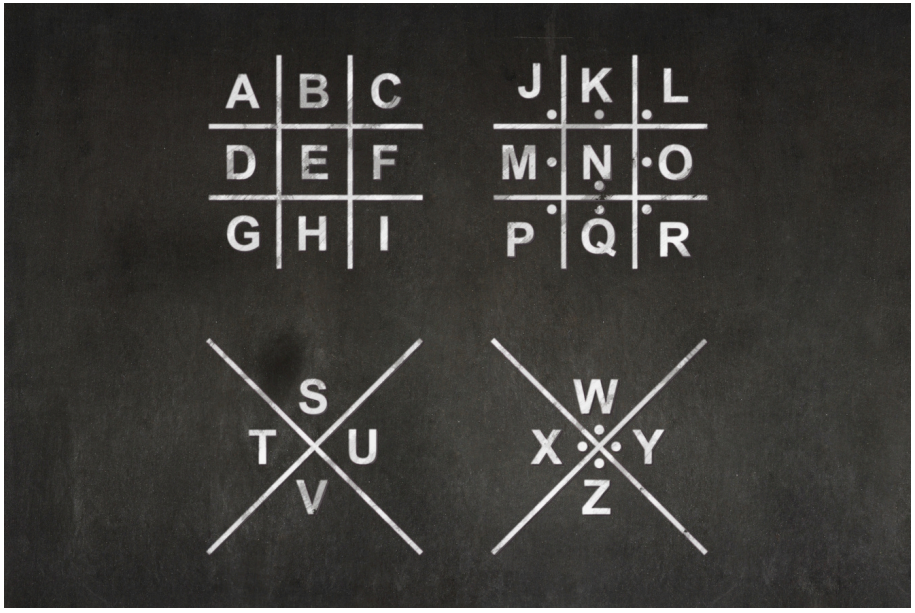
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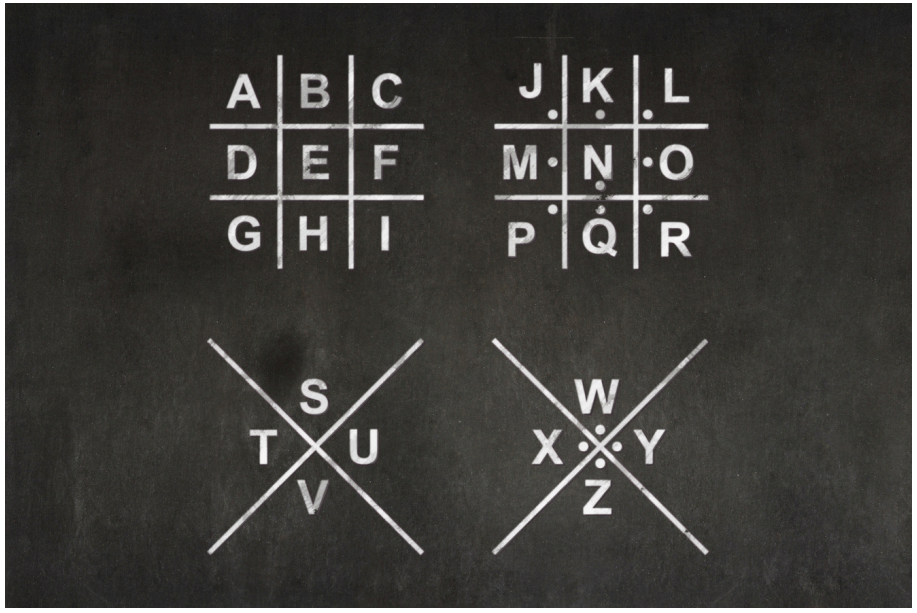

A B C
D E F
G H I
J K L
M N O
P Q R
S
T U
V
W
X Y
Z

Ciphers: Numeral Hint and Answer Card

Hint

Hint:

The placement of the lines and dots matches up with the decoder.

A = 

Answer

Answer:

FRIEND

Fingerprints

Look at your fingerprints and learn how to lift prints.

What you need to supply:

- your fingers or surfaces that already have fingerprints on them
- ink pads and paper or tape, brushes, and cocoa powder/corn starch

Types of Evidence: Fingerprints

READ

Every person has their own unique set of fingerprints. Did you know that we also have toe prints?

The ridges of our fingerprints can help us grip and hold onto things. Each finger has its own print. We can also use fingerprints as a password to log into a phone or computer; this is called biometrics. Fingerprints can be found on objects at a crime scene and we can collect them and use them to figure out who was there.

THINK

Have you ever left a fingerprint on something? What type of surfaces show fingerprints the best: plastic, glass, wood, metal, grass, dirt, or something else?

DO

You will be making fingerprints and then looking at them to find different patterns.

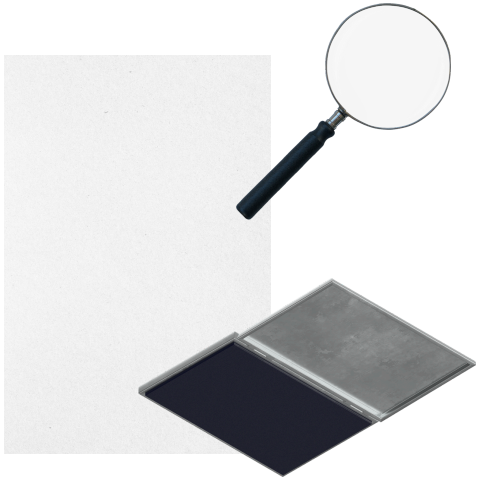
You can make fingerprints in two different ways:

1. Using an inkpad or marker
2. Picking up a fingerprint off of an object.

After you have fingerprints to look at, compare their shapes and patterns to the Fingerprint chart. See if you can find the main Ridge Pattern for each fingerprint and some of the other ridge characeristics.

Fingerprints: Ink Pads and Markers

One way to look at your own fingerprints is to:



1. Press your finger gently onto an ink pad. Press down and lift straight up
2. Then press your finger firmly onto a piece of paper. Press straight down and straight up. Do NOT wiggle your finger at all!
3. Wash your finger off
4. Compare your prints to the Fingerprint Ridge Patterns card and figure out what types of prints you have. You can use a magnifying lens if the patterns are hard to see.

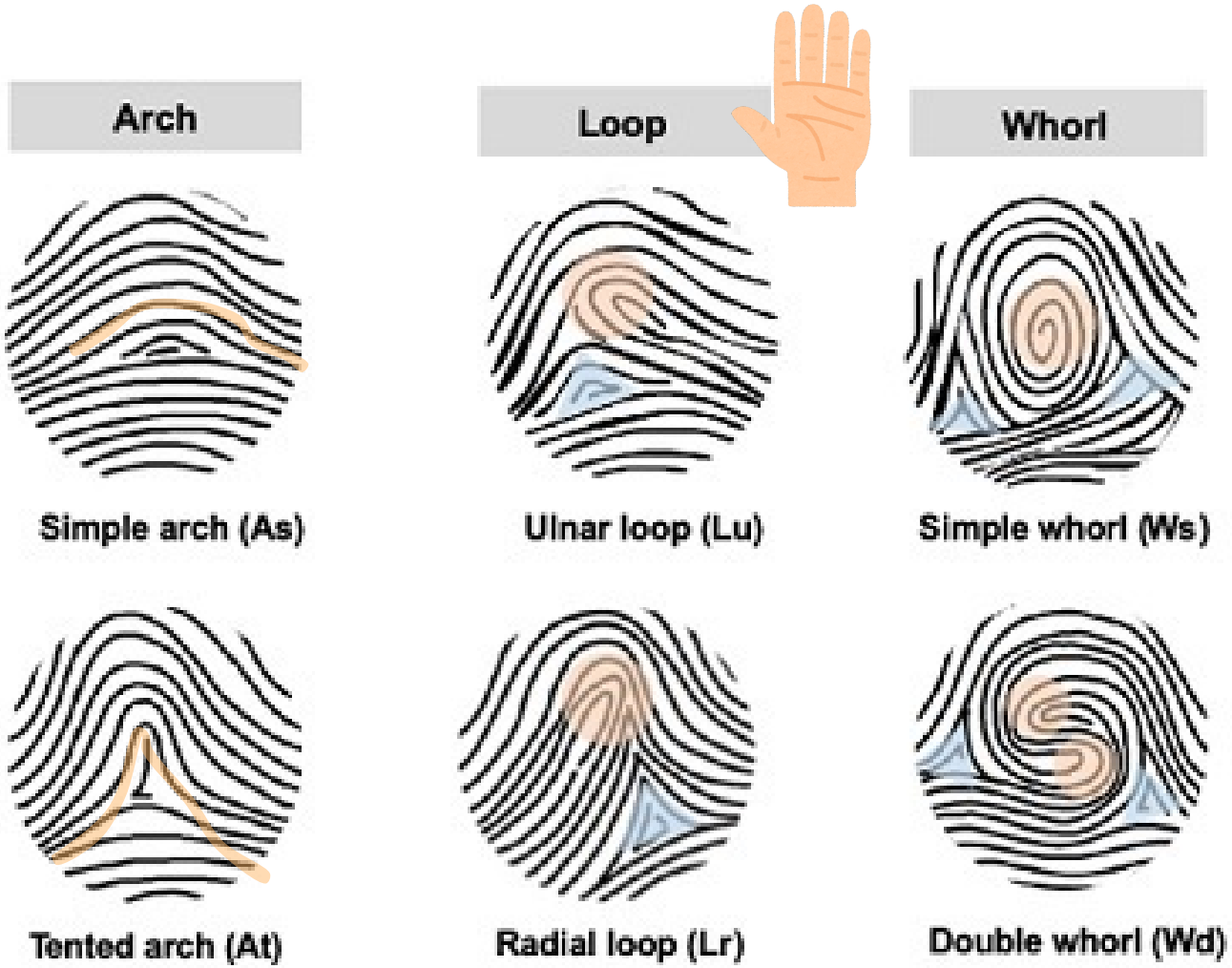
If no one in your group is allergic to latex or balloons, you can follow the same steps using a latex balloon instead of paper. Gently stretch the balloon and then lay it flat before you start. Put the ink in the middle of the widest part of the balloon. Let the ink dry a little bit. Then you can blow up the balloon to be able to see the print better.

Fingerprints: Lifting or Picking up Fingerprints

To lift of pick up fingerprints, you'll first need to find a clear fingerprint on an object. After you find a fingerprint you will need to:

1. Gently squirt or sprinkle fingerprinting powder over the print. You will want to use just enough to cover the print. If you don't have fingerprinting powder, you can use corn starch or cocoa powder.
2. Very gently, brush off the extra powder. This step might take some practice to get right.
3. Place a piece of tape over the fingerprint. Press down firmly.
4. Carefully peel back the tape.
5. You can put the tape on light or dark paper to save the print.
6. Analyze the print and see what type of Ridge Pattern and Ridge Characteristics the print has.

Fingerprints: 6 Common Ridge Patterns



Ulnar Loops have the open part of the loop pointing towards the ulnar bone and pinky.

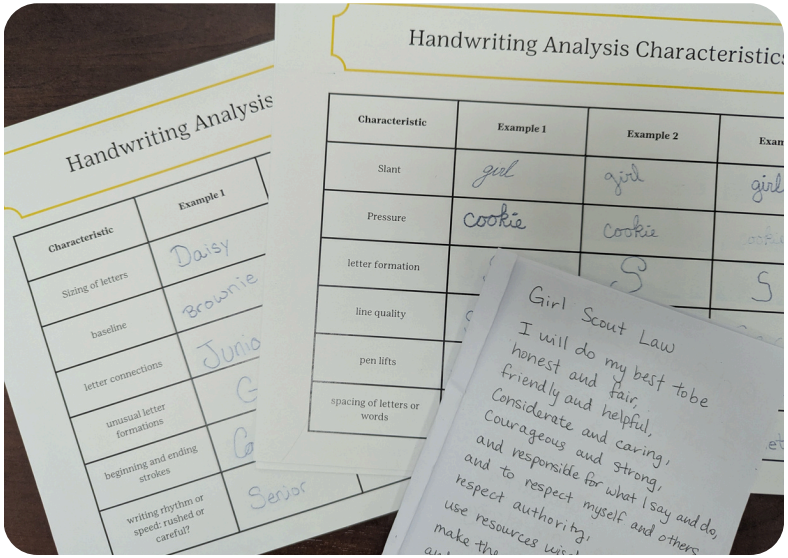
Radial Loops have the open part of the loop pointing towards the radial bone and thumb.

Fingerprint diagram from Forensic: https://www.forensicmag.com/582622-Fingerprint-Patterns-Linked-to-Limb-Development-Genes/

Fingerprints: Ridge Characteristics

Ridge characteristics are smaller patterns that you will find in fingerprints. They are also sometimes called Minutiae. You will find lots of minutiae in each fingerprint. In court, you need to have at least 8-12 matching minutiae for a positive ID on a set of prints.

Fork 	Double Fork 	Triple Fork 
Dot 	Delta 	Bridge 
Hook 	Eye 	Short ridge 
Ending Ridge 	Core 	Crossover 



Handwriting Analysis

Learn about handwriting analysis and how to tell different writings apart.

What you need to supply:

- handwriting samples and a “crime scene note”

Types of Evidence: Handwriting Analysis

READ

Forensic Science is when we use science and apply it to investigating crimes. One tool that can be used to investigate crimes is forensic handwriting analysis. A forensic handwriting expert compares people's writing to a note or letter that is part of a crime investigation and figures out who wrote it. They can also look at a signature and analyze it to see if it is a real signature or a forgery, which is a faked signature. Handwriting analysis investigation needs to be done by a trained expert. People who haven't had enough training are more likely to get the wrong answer. This part of forensic science is not perfect and is more likely to get the wrong answer compared to something like fingerprints or DNA.

THINK

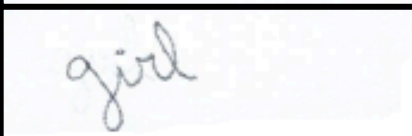
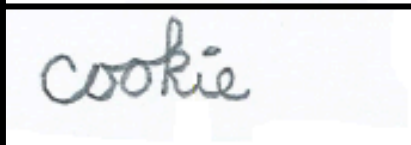
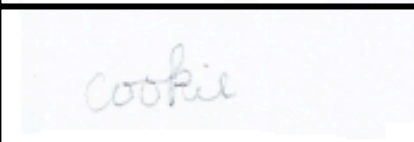
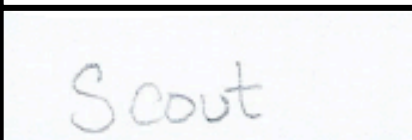
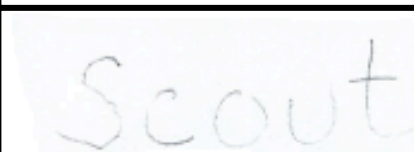
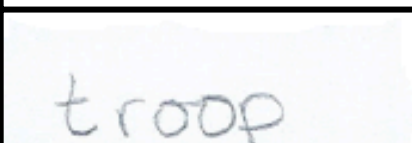
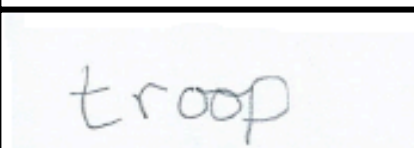
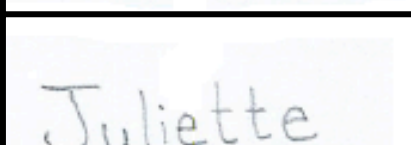
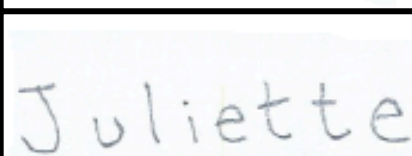
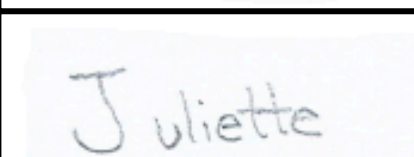
Have you ever tried out different ways or styles for how to write your name?

DO

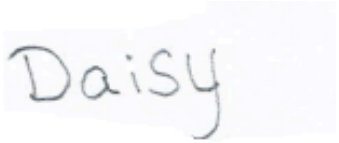
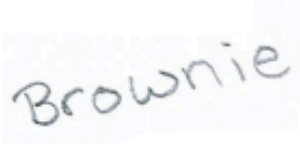
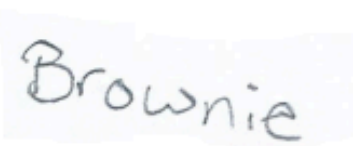
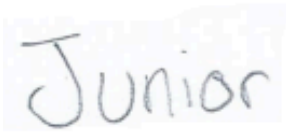
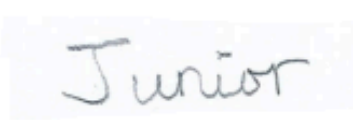
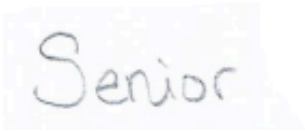
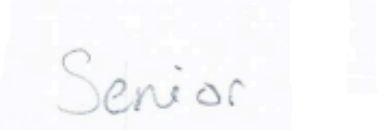
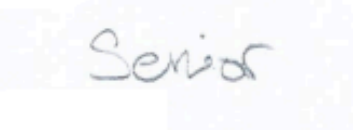
First, look at the Handwriting Analysis Characteristics to learn about some of the different parts of writing.

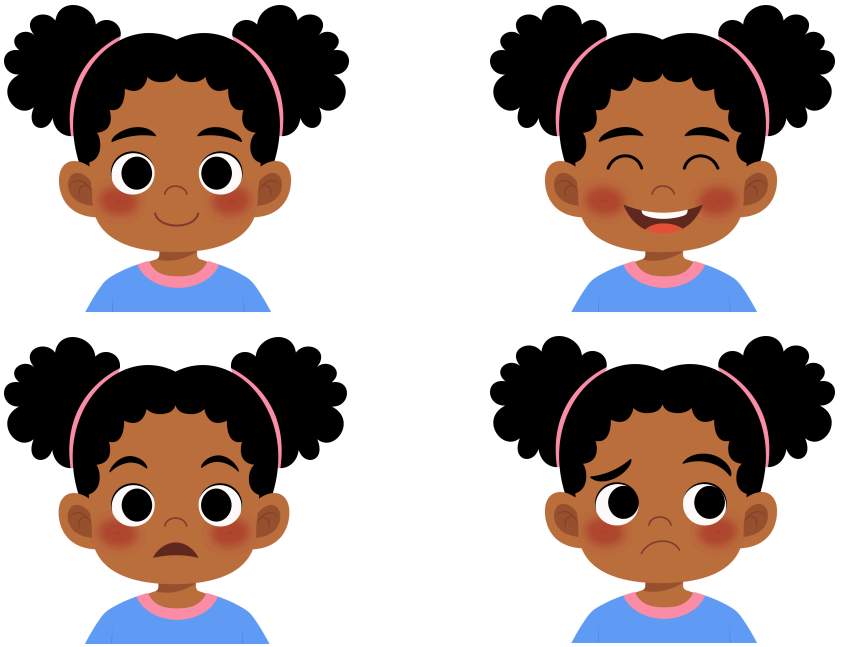
Then, you will be looking at different handwriting samples and seeing if you can figure out which person wrote the note that was found at the crime scene.

Handwriting Analysis Characteristics

Characteristic	Example 1	Example 2	Example 3
Slant			
Pressure			
letter formation			
line quality			
pen lifts			
spacing of letters or words			

Handwriting Analysis Characteristics

Characteristic	Example 1	Example 2	Example 3
Sizing of letters			
baseline			
letter connections			
unusual letter formations			
beginning and ending strokes			
writing rhythm or speed: rushed or careful?			



Body Language

Learn about how body language can help an investigator figure out if something is true.

What you need to supply:

- nothing

Types of Evidence: Body Language

READ

When you pay attention to a person who is speaking, you are listening to their voice and their words, but you are also watching their hand motions and the expressions on their face. When someone is telling a happy story, we would expect them to be smiling, the tone of their voice to be happy and upbeat, and their face and body to look excited or relaxed. We would not expect someone to tell a happy story with a frown on their face, their eyebrows angled in an angry or frustrated expression, or their hands to be balled into fists. Our body language is how our hands, face, and body look and what that means. When someone tells us the truth, we usually expect their body language to match their story. It doesn't always match, but a lot of the times it does.

THINK

What does a happy face look like? What might the rest of their body be doing if a person is happy?

DO

When an investigator is interviewing a witness, they are often looking at the person's body language to see if it matches their face and their story.

You will play a game called two truths and a lie and see if you can change your body language to try to hide which one is the lie. The first person in the group will say three things about themselves or things they've done but only two will be true. Everyone else in the group has to watch their body language and listen to their voice to see if they can guess which of the three is the lie. After everyone has guessed, the person who told the three things will say which one was the lie. Take turns so that everyone can share their three things.

Voice Analysis

Learn how to tell apart different people's voices by their sound patterns.

What you need to supply:

- nothing

Types of Evidence: Voice Analysis

READ

Each person's voice is unique. Your voice is the sound that you make when air passes through the vocal cords in your throat and out your mouth. You make different sounds by changing the shape of your mouth and putting your tongue in different places. Think about where your tongue is in your mouth when you say the letter T versus when you say the letter K or the letter P. You'll learn about the different characteristics of your voice in this activity. Investigators can analyze voices and try to match a person's voice from a video tape or recording to an actual person.

THINK

Think about when you talk with your normal voice and in a whisper, what are you doing with your body to make those different sound levels?

DO

Read about the different voice characteristics.

After that, each person in your group will introduce themselves and tell you their name, favorite color, and something they think is fun.

Then one person will close their eyes and the rest of the group will choose one person to talk and say "I'm a Girl Scout. Who am I?" The person with their eyes closed will have to guess who was talking. Take turns being the guesser.

Voice Characteristics

Pitch: how high or low a voice is. This is determined by your vocal cords. You can open and close them and change how the sound vibrates. This makes your voice higher or lower.

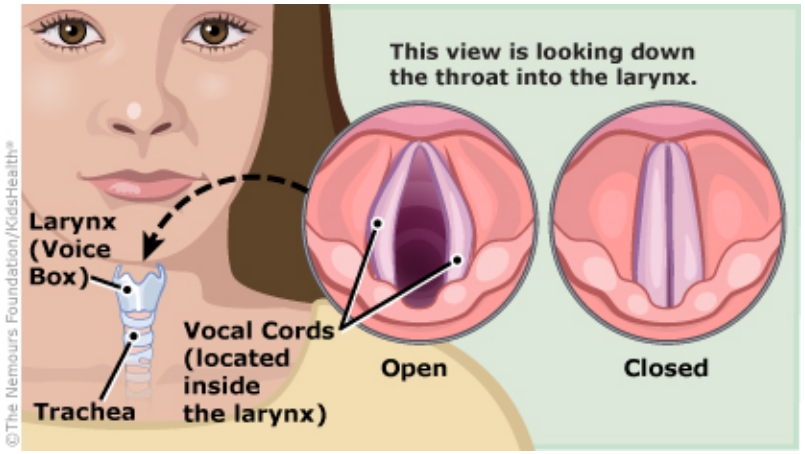


image from Nemours Kid's health

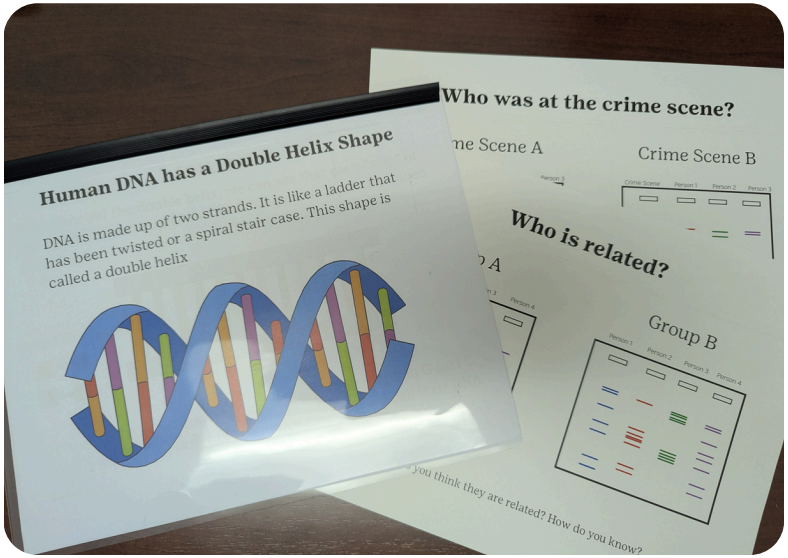
Volume: how loud or quiet your voice is. This is determined by how much air you push through the vocal cords.

Pace or rate: how fast or slow you speak

Articulation: how clearly and carefully you make each sound

Resonance: the way the sound vibrates in your head, nose, and chest. You can sound nasally or have a deep voice

Emphasis: the way you put more stress on specific words to make them more important



DNA Fingerprinting

Use DNA data to figure out which suspect committed a crime or if people are related to each other.

What you need to supply:

- Nothing

Types of Evidence: DNA Fingerprinting

READ

DNA Fingerprinting can also be called DNA Gel Electrophoresis. When we find DNA at a crime scene or if we need to compare two people's DNA to see if they are related, we can do DNA fingerprinting. We follow a specific process and at the end, we have a picture of each person's DNA that has been broken up into different size pieces. We can compare the pictures to see if someone was at a crime scene or if they are related to another person.

THINK

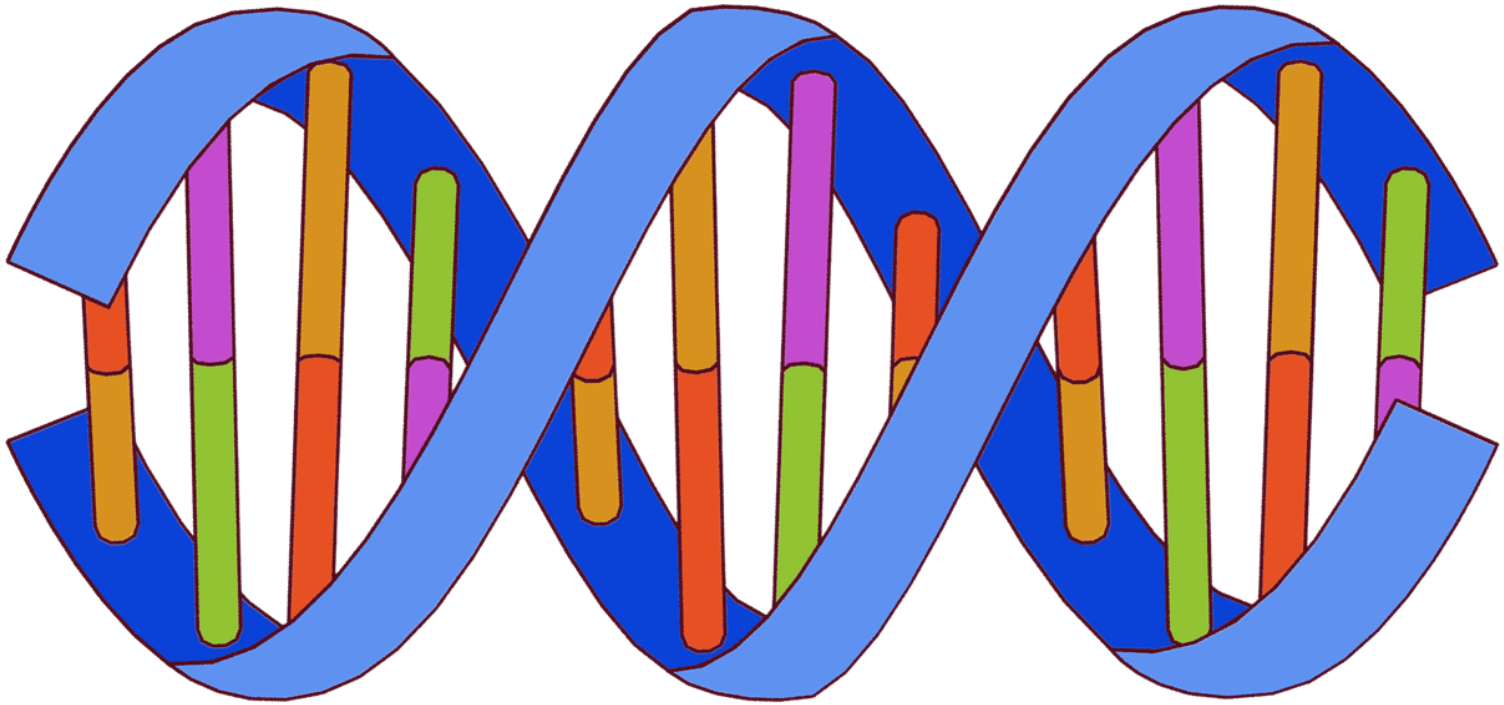
Have you heard of DNA before? What do you already know? What are you curious about?

DO

Read through the booklet about DNA fingerprinting and then try to compare patterns on different DNA fingerprinting examples and see if you can figure out who is related and who was at a crime scene.

Human DNA has a Double Helix Shape

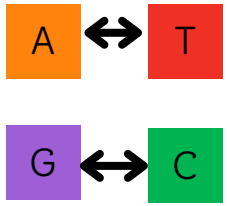
DNA is made up of two strands. It is like a ladder that has been twisted or a spiral stair case. This shape is called a double helix

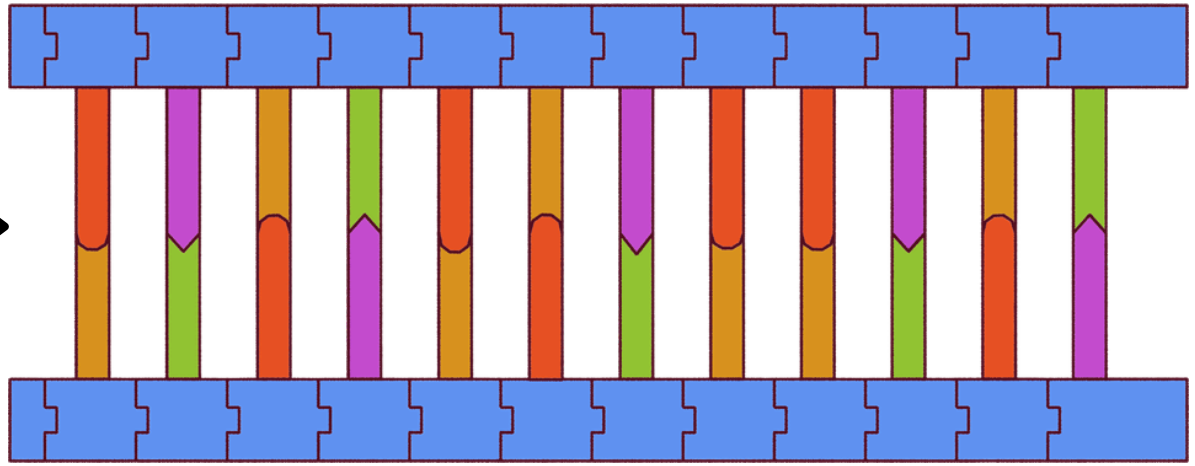


DNA Code

If we unwind the double helix, we can see that each “step” of the ladder is made up of two matching parts. These are called Base Pairs.

Base Pairs →



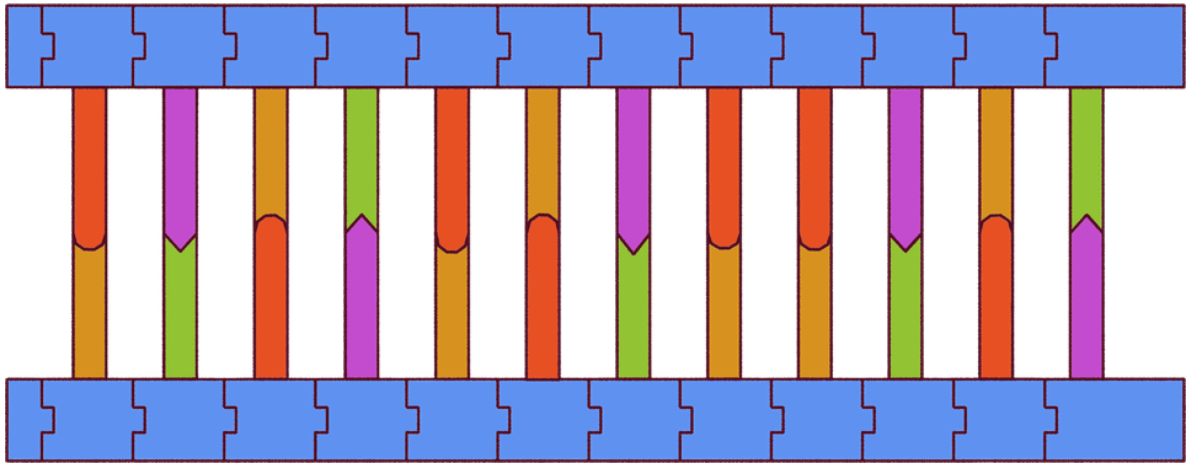


In human DNA, we have A and T for one base pair and G and C for the other. The order of these pairs is what we call your DNA code.

Cut up the Code

Scientists figured out that we could cut up the DNA at specific spots using something called a Restriction Enzyme. These enzymes always cut at the exact same code. For example, one enzyme would cut whenever it finds the code GAATTC.

Restriction Enzyme is like a scissors for DNA



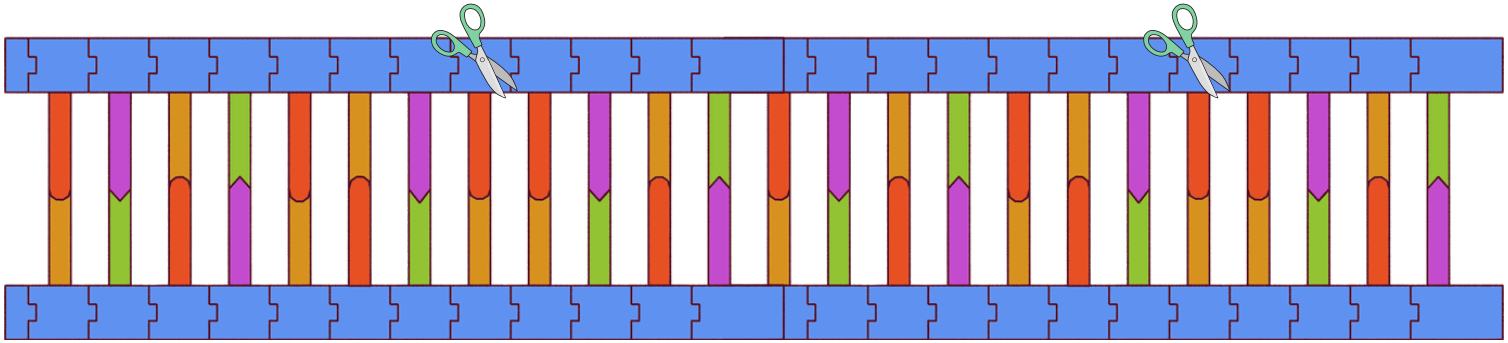
Because everyone's DNA code is different, when we cut the DNA with a Restriction Enzyme, it will cut everyone's DNA differently.

Restriction Enzymes

This Restriction Enzyme will always cut at a certain spot. In the example below, it will cut when the top line is orange, purple red. It will cut after the red.

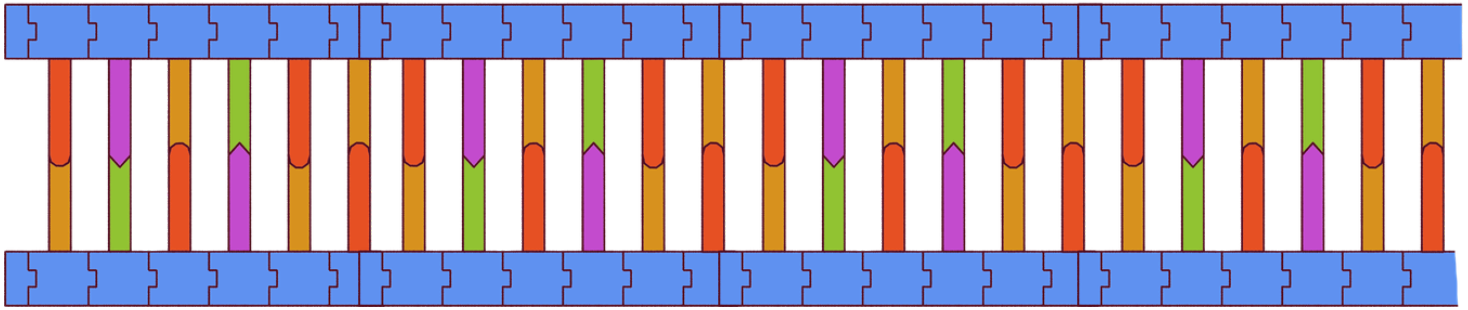
Example 1

In this strand of DNA, there are only two times that we see orange, purple, red.



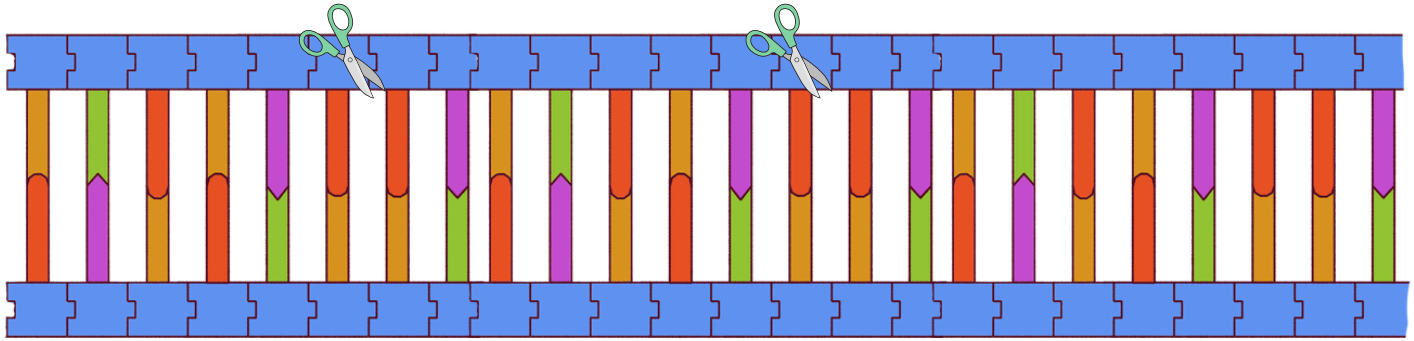
Example 2

In this example, the strand of DNA doesn't have any times where the code is orange, purple, red so it doesn't get cut.



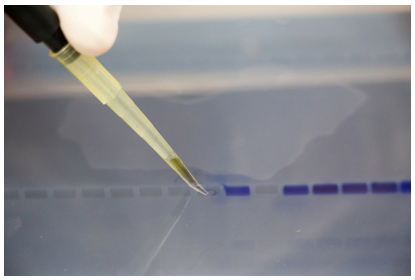
Person 3

In this strand of DNA, there are only two times that we see orange, purple, red.



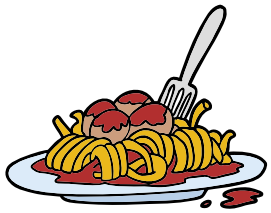
DNA Fingerprinting

(also called DNA Gel Electrophoreses)

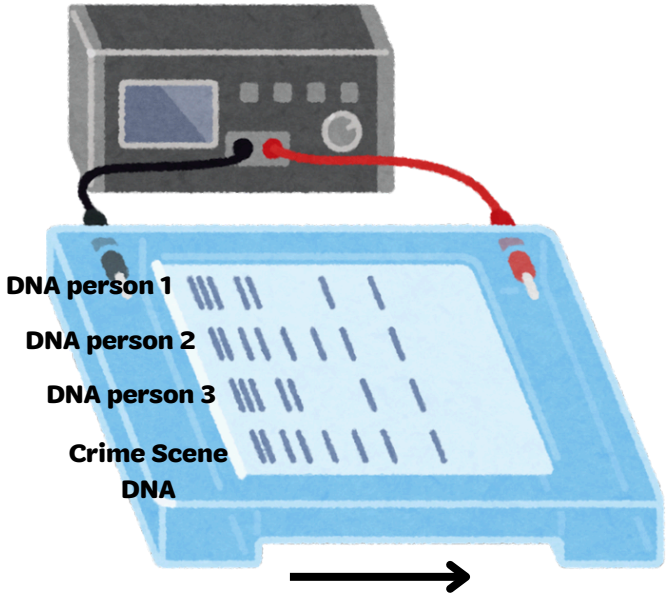


The cut up DNA pieces are dyed blue so that we can see where they are and put in a own hole inside of a gel (kind of like clear Jell-O). Each person's DNA goes in its own hole.

Electricity is used to push the DNA through the gel. The big pieces have a hard time getting through the gel and get stuck right away. The small pieces move through the gel to the other end.

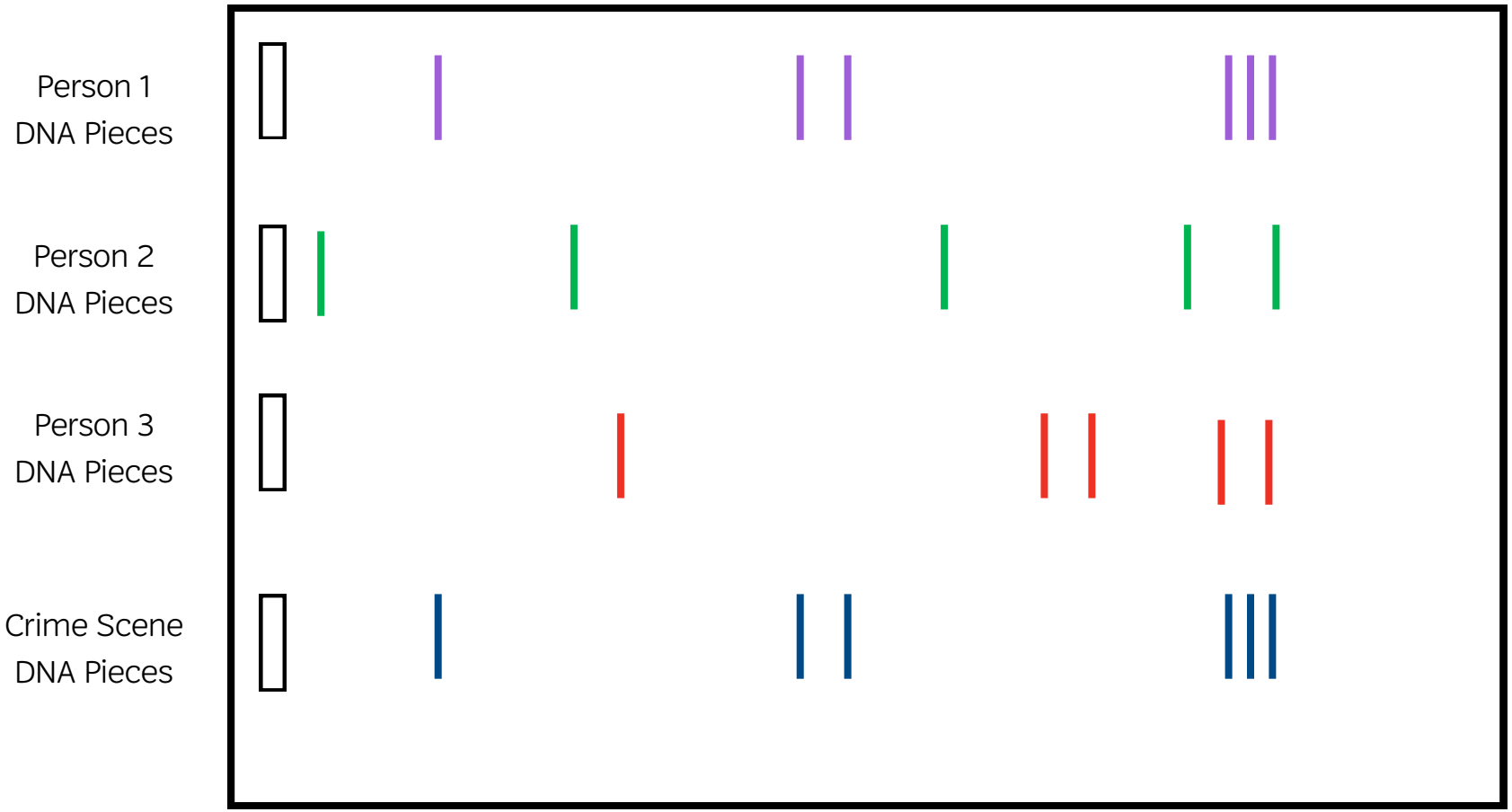


You can think of it like a plate of spaghetti and meatballs. The Jell-O's gel is like the spaghetti noodles. When you put the sauce and meatballs on top of the noodles, the smallest parts like the sauce make it through to the bottom. The chunks of onion or garlic make it halfway down. The bigger, broken chunks of meatball make into the top layer of noodles, and the full meatballs get stuck at the top.



DNA pieces are pushed through the gel

DNA Fingerprinting Results



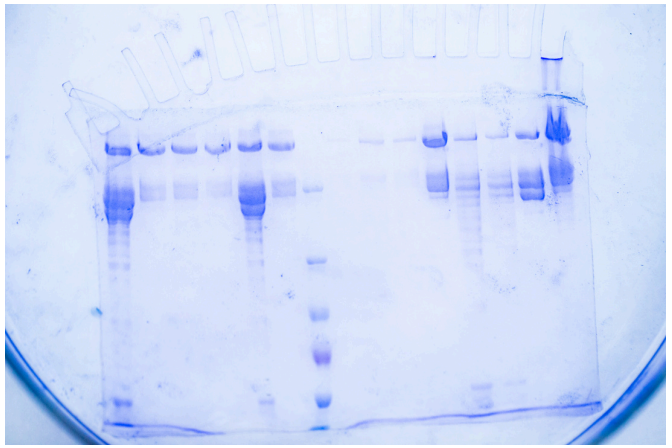
After we run electricity through the gel, the DNA pieces spread out by size. We put some chemicals on the gel to make the DNA easier to see. Then we can look at the pattern the DNA pieces make and see if anyone's DNA pieces match the crime scene DNA.

Reading DNA Fingerprinting Results

Did you figure out if any of the people's DNA was at the Crime Scene? How did you know?

Challenge: Can you explain your answer using the terms Base Pair or length?

This is what an Actual Result looks like

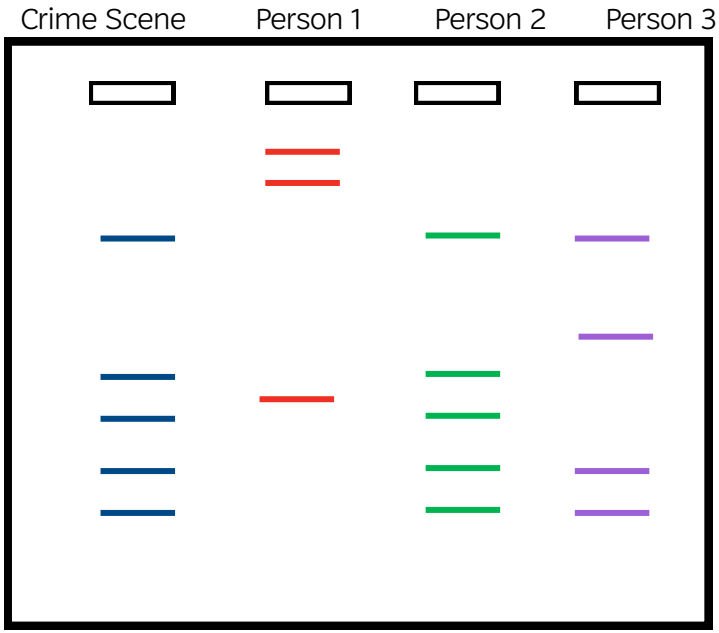


Results of Relatives

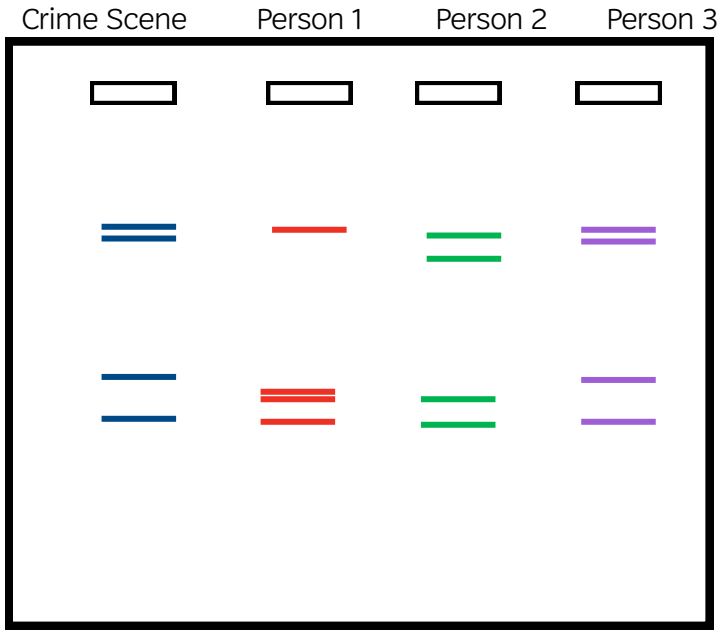
If someone is a brother or sister, parent, or child of another person, they will share some of their DNA, but won't be an exact match. We can look to see how many lines, or bands, they have in common with each other and work backwards to figure out how they might be related.

Who was at the crime scene?

Crime Scene A

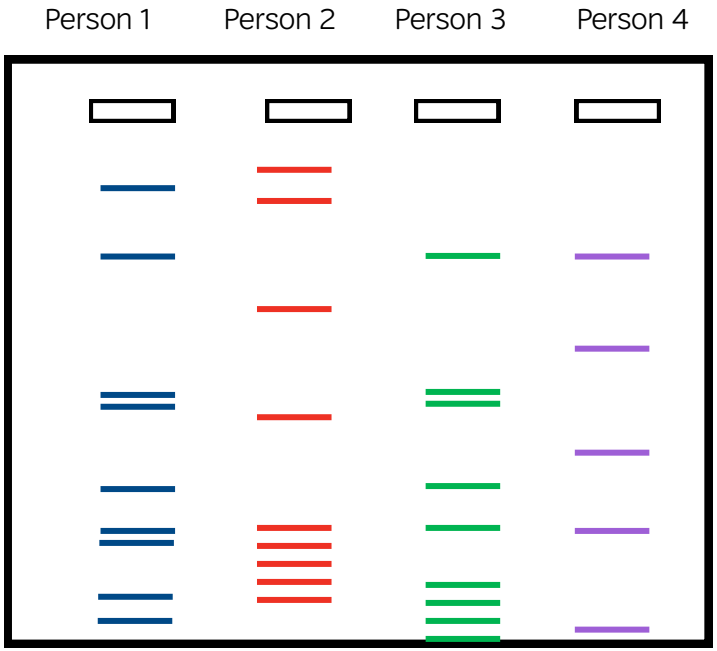


Crime Scene B

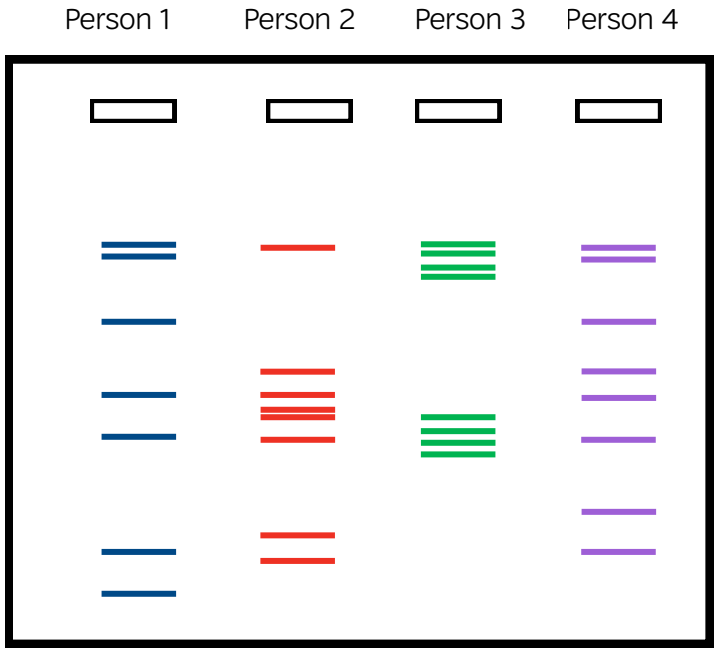


Who is related?

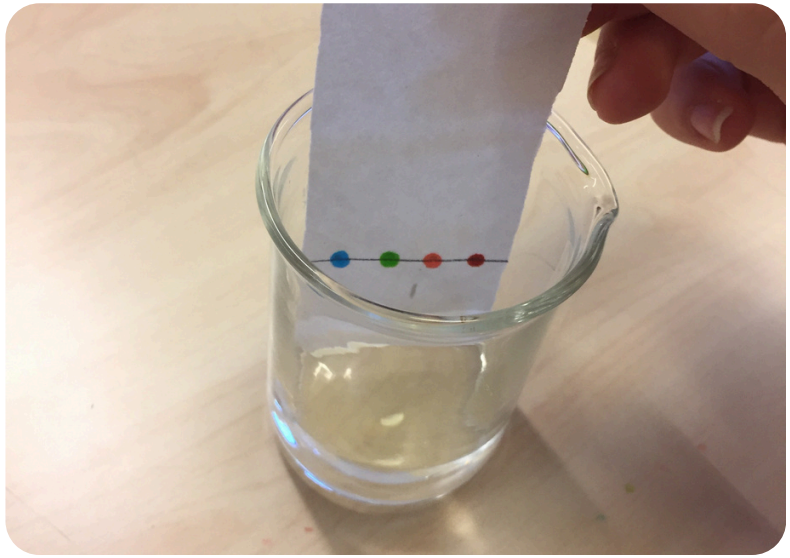
Group A



Group B



Why do you think they are related? How do you know?



Chromatography

Follow the path of the ink to compare pens to see which ink matches

What you need to supply:

- chromatography paper (coffee filters or thick paper towels work, but the pattern is harder to see), water, cups, markers or pens, pencil, ruler

Types of Evidence: Chromatography

READ

Chromatography is a type of science we use to separate a mixture into all of it's separate parts. It can be used to figure out what type of chemical something is. It can also be used to figure out if two types of ink from a pen or marker match. We use a process called paper chromatography to split the ink apart into all the individual colors that make it up.

THINK

Have you ever seen ink from a pen or marker change color on a piece of paper? If you have, can you remember what got on the paper that caused the color to change?

DO

You will be doing chromatography on markers. You will put a dot of the markers or pen you are testing on the start line. Then you will put that end of the paper into a cup that has a little bit of the liquid or solvent at the bottom.

The liquid will start moving up the paper and the ink will also start running up the paper. As it runs upward, it will split into its different parts. You can compare the patterns each ink makes to figure out if they are using the same ink or different ink in the different markers and pens.

Chromatography

Step 1: If there isn't already a line about ½" to 1" up the paper, lightly draw a straight line across the paper.

Step 2: Put a dot of each of the inks you are testing

Step 3: Put the chromatography paper into the cup or beaker with liquid in the bottom. The liquid is called solvent. For regular markers you will use water.

Step 4: Watch the liquid and ink travel up the paper. After it has reached close to the top and the ink has split apart into different colors, you can compare the different patterns.

Impressions

Create an impression and try to figure out which tools another Girl Scout used.

What you need to supply:

- modeling clay and a variety of objects or clay tools

Types of Evidence: Impressions

READ

An impression is a mark or pattern left behind when one object pushes into another. Examples of impressions are footprints or tire marks left in mud, teeth mark left in an apple, or tool marks left on wood or other surfaces. Forensic scientists take pictures of these impressions and sometimes make a cast or mold of them by filling them in with plaster. You can even make casts of an object using something like play doh.

THINK

Have you ever walked through mud, snow, or wet sand before and left a footprint behind? How could you tell if it was you footprint or an adult's footprint? Could you tell if someone was wearing shoes from an impression?

DO

You will be using the tools in the kit to make some impressions on clay. Each Girl Scout should make a small amount of clay into a flat slab.

Then you will each use 1-3 different tools to make marks in your clay. Think about how hard or soft you will push into the clay, which part of the tool you will use, or if you'll use multiple parts of the tool.

Trade spots with a partner and see if your partner can guess which tools you used to make an impression.

Microscopes

Look at evidence up close under a microscope

What you need to supply:

- microscopes and slides, magnifying glasses, animal hair, human hair

Types of Evidence: Microscopes

READ

Magnifying glasses help make objects look bigger so you can see more details. You have to start holding them near the object and slowly pull them back toward your eye until the object comes into focus. Microscopes work the same way, but they can magnify the objects even more. You have to be careful to not touch the lens that magnifies things because it can scratch really easily.

Forensic Scientists look at hair, soil, paper, and other objects under the microscope to see if samples match or not.

THINK

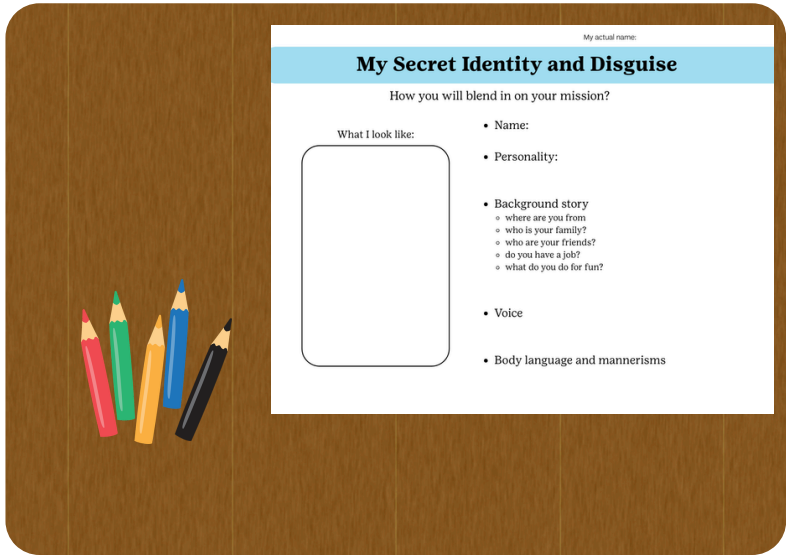
Have you ever looked at hair under a magnifying glass or microscope before? What do you think it would look like?

DO

Take a small piece of hair and look at it under a magnifying glass first. Then look at it under a microscope. What do you notice?

Look at someone else's hair under a microscope. Is it the same as yours or is there anything different about it? What about animal hair, does it look any different?

Take a look at paper or other objects with the magnifying glass or microscope. Does anything surprise you?



Design a Disguise

Create your own spy identity and disguise

Supplies you need to provide:

- pencils
- copies of the planning sheet or paper

Design a Disguise

READ

As a spy, when you disguise yourself you would change your name and how you look. You would probably also change details about how you talk or walk. These are called mannerisms. You might change how you stand or sit, how you smile, or if you use your hands to talk. You are creating an alternate personality or character for yourself to become.

THINK

What name would you pick out for your spy personality?

DO

You will be creating a plan for a disguise for your spy personality. You will need to think about your:

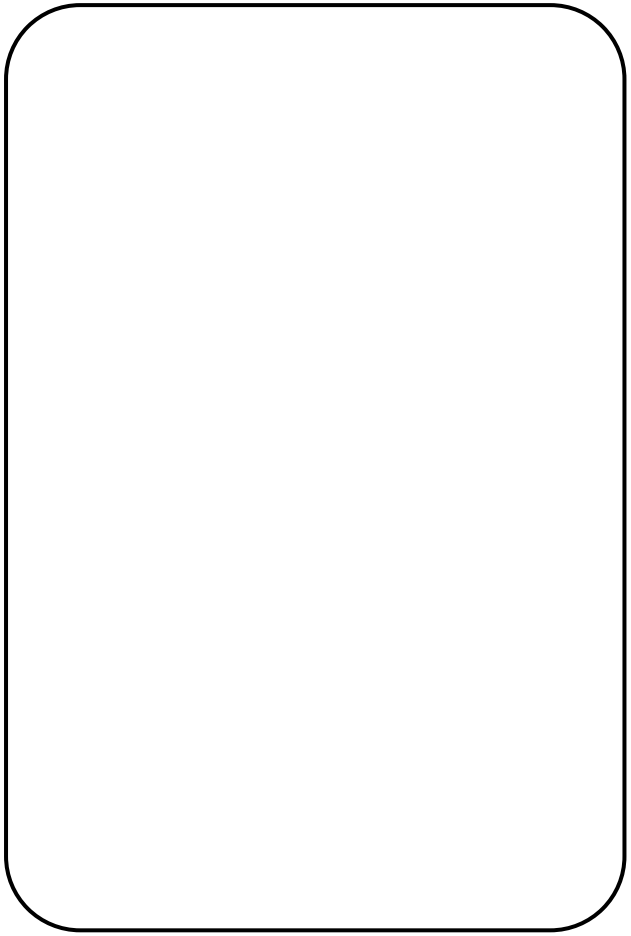
- personality
- a background story
- voice
- body language and mannerisms
- what you look like
- how you will blend in on your mission

My actual name:

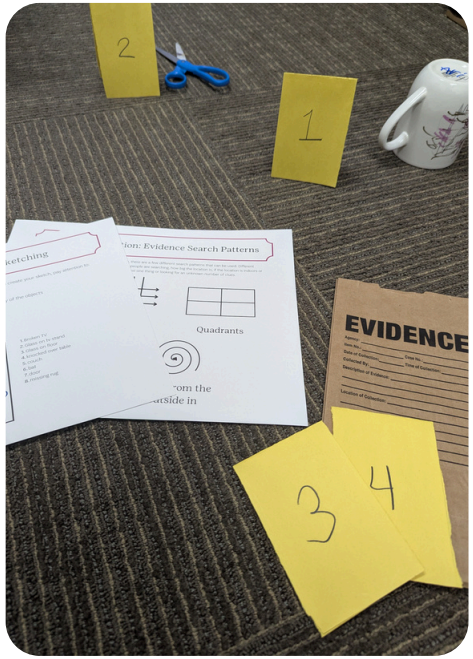
My Secret Identity and Disguise

How you will blend in on your mission?

What I look like:



- Name:
- Personality:
- Background story
  - where are you from
  - who is your family?
  - who are your friends?
  - do you have a job?
  - what do you do for fun?
- Voice
- Body language and mannerisms



Evidence Collection

Learn how to search for and collect evidence

You will need to supply:

- you will need to set up a crime scene for the Girl Scouts to draw. You can add different items that aren't usually found in your meeting room, rearrange items, knock over or remove items, etc
- Yellow paper with numbers for evidence markers
- Pencils and paper
- Optional: Crime scene tape

Evidence Collection

READ

In the 1940s, a woman named Frances Glessner Lee changed the way that detectives investigate crime scenes. As a hobby, she created doll houses or dioramas of unsolved crimes and included every tiny detail that she could find about the scene. Instead of focusing on gut instincts, she focused on observations and paying attention to details. These dioramas became known as the Nutshell Studies of Unexplained Death or the Nutshell Dollhouses. These dioramas were meant to help find the “truth in a nutshell” which means that they summarized the important facts.

The Nutshell Dollhouses were used to train investigators in Maryland how to make better observations, pay attention to details, collect evidence, and not let their own feelings get in the way of the case. Frances Glessner Lee is known as the Mother of Modern Forensic Science. She also started the Department of Legal Medicine at Harvard Medical School.

THINK

What do you already know about collecting evidence or making observations?

DO

You will sketch a crime scene. Sketching a crime scene happens before evidence is collected. You will place yellow number markers next to important pieces of evidence so that you can label those on your diagram.

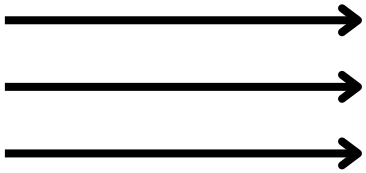
As you create your sketch, pay attention to:

- how close together the objects are
- how big are the objects compared to each other
- is there anything broken, missing, or different than normal with any of the objects
- any other details you see

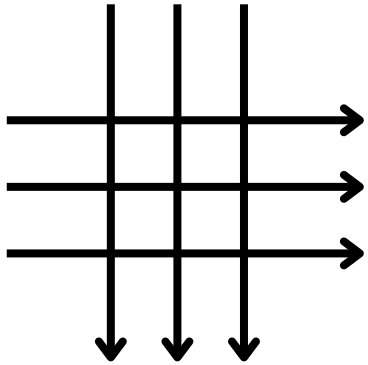
You can start drawing your sketch from one side of the room and work your way to the other, you can work in a spiral going from the outside in or inside out, or you can sketch it out on grid paper.

Evidence Collection: Evidence Search Patterns

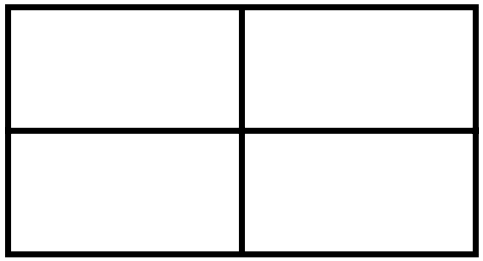
When you are looking for evidence at a crime scene, there are a few different search patterns that can be used. Different patterns might work better depending on how many people are searching, how big the location is, if the location is indoors or outdoors, and if you know that you are searching for just one thing or looking for an unknown number of clues.



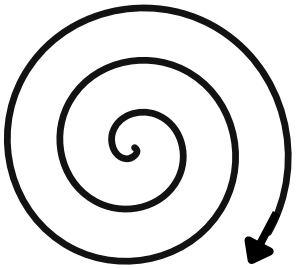
Lines



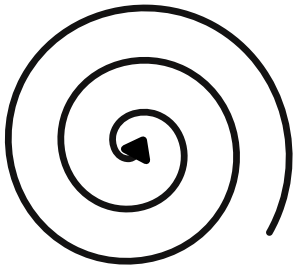
Grid



Quadrants



Spiral from the center out

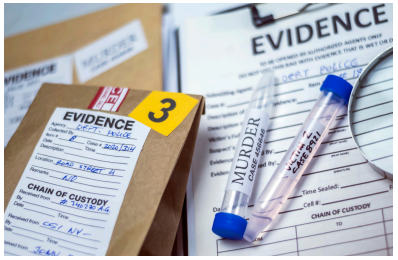


Spiral from the outside in

Evidence Collection: Collecting an Object

If you are going to collect a piece of evidence from a crime scene, you would need to follow these steps:

1. Wear gloves
2. Put an evidence marker with a number on it near the object.
3. Take a picture of the object.
4. Pick up the object with just your fingertips or a tweezers if possible
5. Put the object directly into an evidence bag.
6. Seal the bag shut.
7. Write on the bag: the evidence number, where it was found, who collected it
8. Every time the evidence bag is given to someone else, they have to sign their name on the evidence log to show the chain of custody, or in other words, a list of all the people in the order that they had the evidence bag.

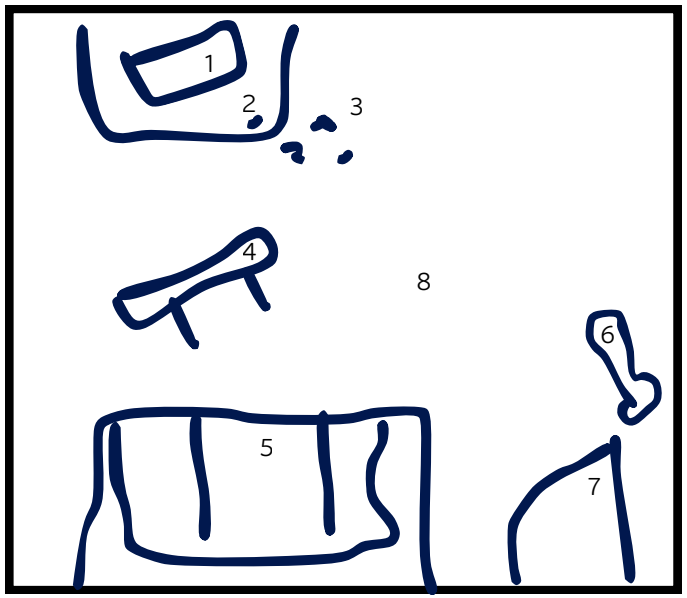


Evidence Collection: Sketching

Sketching a crime scene happens before evidence is collected. As you create your sketch, pay attention to:

- how close together the objects are
- how big are the objects compared to each other
- is there anything broken, missing, or different than normal with any of the objects
- any other details you see

Top view



1. Broken TV
2. Glass on tv stand
3. Glass on floor
4. knocked over table
5. couch
6. bat
7. door
8. missing rug

Solve a Mystery

Play a game while using your investigative skills and solve a mystery!

Options:

- Play a game such as Clue, Junior Detective Mysteries, or an escape room game.
- Visit a local escape room.
- Set up a crime scene for the Girl Scouts to investigate.

Tips for leaders:

- If you use a game you already own or visit a local escape room, make sure that you check that it is age appropriate for your group.

Solve a Mystery

DO

Now it's your turn to solve a mystery! Use your investigation skills to make observations and see if you can solve the mystery.

Your volunteer or badge leader will tell you what type of mystery you'll be solving. As you work your way through the mystery, think about what you already learned to help you solve it:

- Observations: Look, Listen, Smell, Touch, Taste
- Types of evidence: you might rely on just one type or you might have to use several:
  - ciphers
  - handwriting
  - voice analysis
  - body language
  - microscopic evidence
  - DNA
  - invisible ink
  - impressions
  - chromatography
  - fingerprints
- Evidence collection: you might need to collect evidence or just make observations

Good Luck!

Fingerprints you can use if you choose to set up a crime scene or escape room

Congratulations, you've completed the Investigation Badge Series!

What's next?

- **Leave us your feedback!** Do you have suggestions for this Badge in a Booklet or requests for other multi-level badge series? Find a typo or have an activity suggestion? Submit your ideas here.

Submit your feedback

- **Find another Badge in a Booklet or Patch Program**

Find a digital resource

- **Find a Preferred Community Connections Partner** to schedule a field trip as an extension of this badge or for your next badge earning experience.

Preferred Community Connections Partners