



## University of Dundee

### Science@Home Kit

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#DSCfromHome

# Science @ Home

Hello Scientists! Welcome to your Science@Home Kit. In this year's CHRISTMAS LECTURES from the Royal Institution (Ri), Professor Dame Sue Black will tell us all about the real-life detective process she uses in her work as a forensic scientist. Sue's Lectures will cover things like our bodies, how clues are found at a crime scene and how evidence is presented in a courtroom. You can watch the Lectures on BBC Four and iPlayer at 8.00pm on 26, 27 and 28 December.



## Remember:

- Get an adult to help you with any tricky bits.
- Keep a hold of everything in your science box, you will need these to complete your activities and experiments.
- Always wash your hands after doing these.
- Share your pictures and videos with us!
- And HAVE FUN!

**What are you waiting for? Let's get started!**



# What is a Forensic Scientist?






You may have seen forensic scientists on TV or read about them in **detective books**. In real life, a forensic scientist is **someone who uses science to help solve crimes**.

Forensic scientists provide information to the **courts of law** to help judges and juries come to a decision about who may have committed a crime.



## What do forensic scientists analyse?

Wherever we go and whatever we do we leave **traces** of us behind:

-  **footwear marks**
- **fingerprints** 
- **DNA** 
- **hair or fibres from our clothing**

If these traces are recovered and given to forensic scientists, they can do **scientific tests** to find out if the traces can tell us where, when and who might have committed a crime. **So you can see, forensic science plays a very important role in detecting crime!**

We've teamed up with:

the **Leverhulme Research Centre for Forensic Science** and the **Centre for Anatomy and Human Identification** from the **University of Dundee**, along with the **Royal Institution** to bring you this fun investigation you can do at home. **It follows many of the same steps that a real forensic scientist would use!**



# A Christmas Crime!



Santa likes to keep his office at his North Pole workshop **super secure**. That's where he stores his **top-secret naughty and nice lists**. Santa had been kitting out his office with the latest in **high-tech security** when a break-in happened **only a week before Christmas!**



**Help us catch the criminal before Christmas!**



## Item 1: X-ray scans

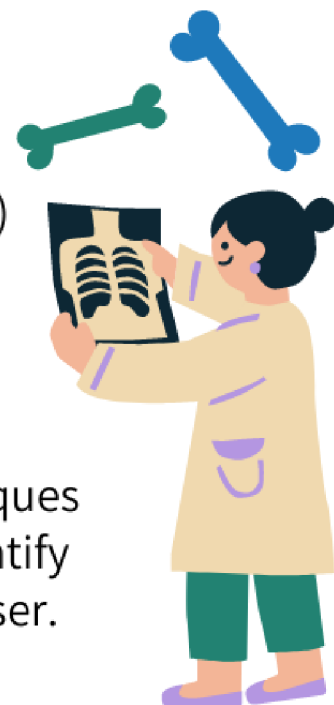
Santa had just fitted an **X-ray body scanner** around his office door at the time of the crime. The scanner captured an image of the bones of whoever broke into Santa's Office!

Forensic scientists who specialise in understanding the human body and bones are called **Forensic Anthropologists**.

They can use their knowledge to predict information like:

- **Height**, from the length of the femur (leg bone)
- **Age**, from the stage of bone development
- Whether the skeleton is **female or male**

**In this activity** you can use some of the techniques that forensic anthropologists use to try to identify some characteristics of our unknown trespasser.





# Activity: Studying the Skeleton



We are going to use x-ray images to estimate the criminal's age!

'Long' bones in the body, including the hand, grow as we get older. By the time we reach **adulthood**, our bones are **fully fused together!**

This fusion of bones is quite **predictable in children**, so by **seeing which bones are fused we can estimate a child's age.** In younger children, the bones will look quite far apart, but as the child grows older the bones will get closer together!



In an X-ray image, the area where bone growth will happen looks like a **dark space or line.**



**This dark space gets smaller as we get older.** As the ends of the bone finally fuse together with the shaft, this line will disappear. So it can no longer be seen in older individuals.

You can see how this process happens in the images below!



1 year



6 years



10 years



14 years



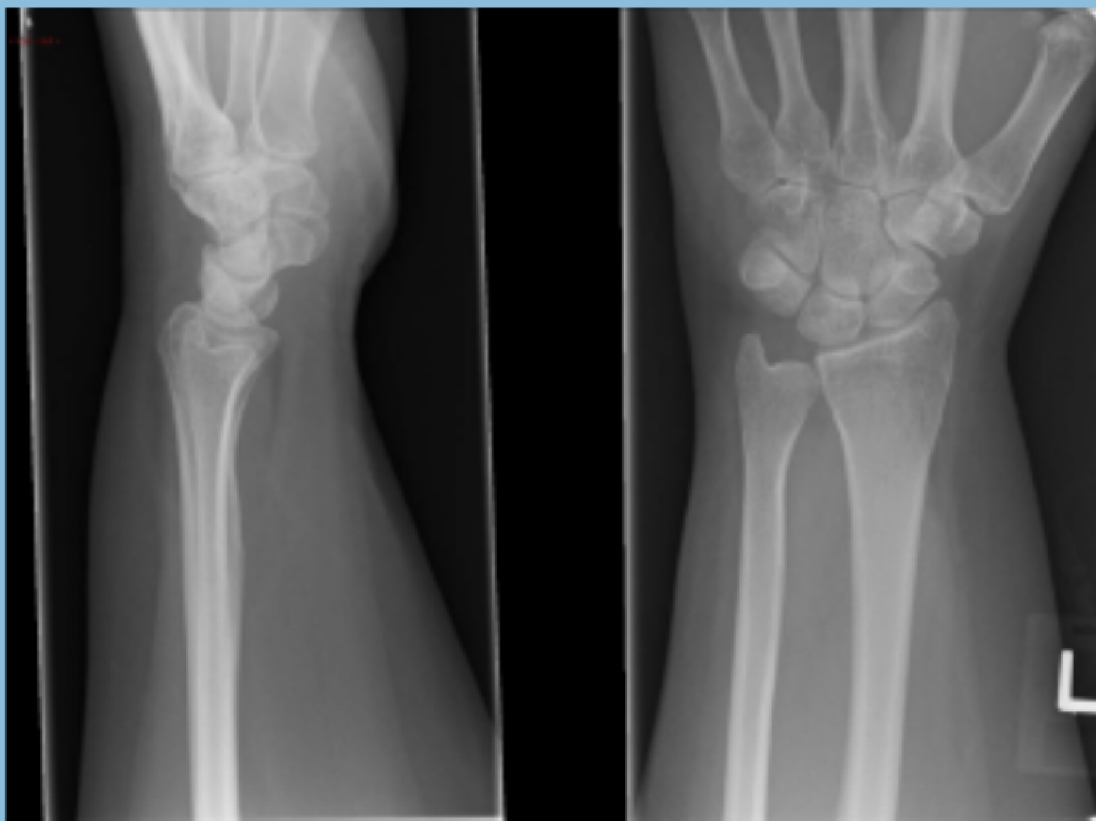
Adult

# What age is the criminal?

Compare the hand x-ray of the unknown individual who has broken into Santa's office, to the examples given on the previous page.

What age, roughly, do you think the culprit might be?

Hand X-Ray of Unknown Individual



If you can, fill out this Mentimeter with your conclusions for this and future activities!



[menti.com/alzkphi5fy9e](https://menti.com/alzkphi5fy9e)



# Item 2: The Crime Scene

Someone has broken into Santa's office! Can you help see what has changed in the office and pinpoint what's changed?

Before the crime



After the crime





# Oh no! Santa's nice list has been replaced with a forgery!

**We need to help Santa find the real one before Christmas Eve!**

But how can we know who committed the crime? We need more **evidence!**

The **North Pole Police** have collected some evidence from the scene of the crime that might help us to identify who stole the nice list.

## Item 3: Fibres

On Santa's chair some **clothing fibres** were collected. It's likely that these came **from a piece of clothing** like a jumper or a hat.



**Small pieces of materials** (e.g. fibres, hair, glass, paint, pollen, soil) **can transfer** between people, objects and between people and objects when they come into contact with each other.

If these materials are **not disturbed**, there is a chance they can be recovered and examined by a forensic scientist.

**Try collecting fibres yourself to learn how forensic scientists gather fibres from a crime scene. Then examine the fibres found in the office and compare them to some fibres taken from several suspects.**



# Activity: Finding Fibres

Recover traces of fibre evidence from clothing using methods similar to the ones forensic scientists use in their laboratories!

## You will need:

- Your roll of sellotape
- Scissors
- Magnifying glass
- Felt-tip pen
- Fabric (any used clothing, bedding)
- Examination sheets



**Examination sheets** are used by forensic scientists to **record everything that they do**. Forensic scientists will fill in all information about **what** they do, **where** and **when** they do it (location, time and date) and will draw diagrams and take notes of what they find. They will also sign, number and date every page of their notes.

You should use one examination sheet for each item of clothing.

We've provided you with one with your kit, but you can easily make more with a pen, ruler and paper!



# Finding Fibres continued....



## Instructions:

1. Find a **flat surface** to work on. Make sure it is **clean** and free from anything that could contaminate your experiment
2. Lay down your fabric/item of clothing and **pick one area** you will work on, for example, the right sleeve of a jumper
3. Carefully peel off a piece of tape from the roll (about **10cm**)  
Hold both ends of the tape and press the sticky side down onto the clothing. **Make sure the whole piece sticks to the clothing.**



4. Lift the tape and **repeatedly stick it on the fabric** a number of times to cover the area you are working on. **Then stick the tape onto the examination sheet.** Make a note of which area of the garment each of your pieces of tape is from (these are the areas A, B, C, D on the examination sheet).
5. Repeat this process again so you **have multiple pieces of tape on the same examination sheet.**

# Finding Fibres continued....



6. Using your eyes, or with the aid of a magnifying glass, carefully look at the materials that you have collected from the clothing.
- **What can you see?** – Are there any fibres from other clothes or fabrics? Are there any other materials like dust, hair, or dirt? **These are the clues we are looking for!** They might tell us where the person who wore the clothes has been, or if they have met other people.
7. As you examine the sheet, use a felt tip pen or sharpie to **circle any particles or fibres that are not originally from your piece of clothing** (e.g. different colour or fibre material).



	1	2	3	4	5	6	
A							Tape number 1 From white jumper Right sleeve front
B			(Hand-drawn red squiggle)				
C					(Hand-drawn button)		Tape number 2 10.12.22
D		(Hand-drawn blue squiggle)					



8. **Try the experiment again with another item of clothing** and see if you find anything different! You can try using clothes that are different colours or made of different materials to see if you find anything new!

Don't worry if you don't find many materials. A lack of evidence can also give us information. Maybe the clothing you picked is new or recently washed or maybe it's made with a fabric that other material is less likely to stick onto.



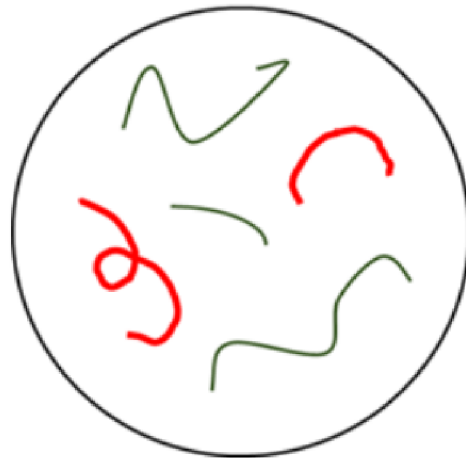


# Where did the fibres on Santa's Chair come from?



Compare the fibres collected from Santa's chairs to fibres from other fabrics around the workshop.

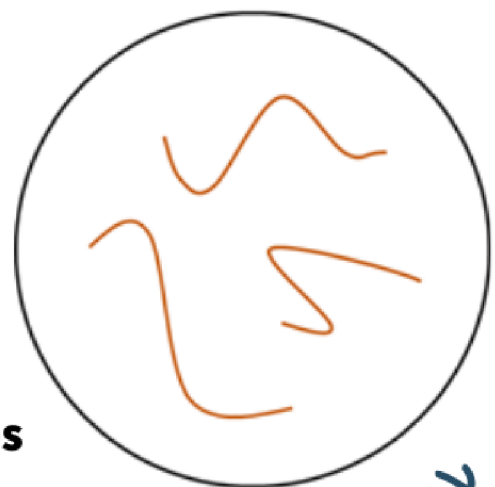
## Magnified fibres found on Santa's chair



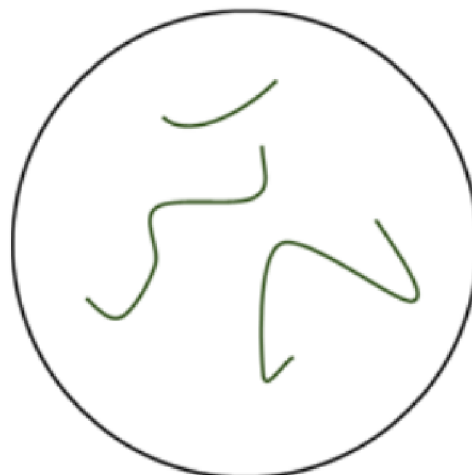
**Santa's Coat fibres**



**Reindeer Blanket fibres**



**Elf Coat fibres**



# Item 4: The Fake Nice List



## Who could have forged the nice list?



The ink used to create the fake nice list can also be investigated to figure out what kind of pen it came from!

When you write with a pen it may look like it has only one colour, but the ink is actually made up of a **bunch of pigments and dyes of different colours**.

Different types of pens (e.g. fountain pens vs felt-tip pens) **will use different pigments and dye, to make the same colours**.

By **seperating out** the different dyes out of the ink, we can compare them with another pen or ink to see if they are the same. This is known as **chromatography**.

Note: most inks are **mass produced** so it isn't always possible to identify the specific pen that the ink comes from.



## Activity: Inkredible Inks

### You will need:

- Kitchen paper cut into 2-3cm strips
- A small beaker
- Tap water
- Pens

### Instructions

1. Make a spot of ink on a strip of the kitchen paper with your pen, about **1.5cm** from the bottom of the strip. **Use a different strip of kitchen paper for each pen.**
2. Put **1cm depth** of tap water into the beaker.



# Inkredible Inks continued...

3. Carefully place the kitchen paper into the glass so that the end with the ink dips into the water. **Make sure that the water doesn't cover the ink spot!**
4. Watch as the water slowly moves up the kitchen paper, taking some of the ink with it as it goes!
5. Once the water has travelled almost to the top of the strip of paper take the paper out and allow it to dry.



## Comparing the pens

Repeat the above steps with different pens. Make sure to keep track of which strip of paper is for each pen!

Wait for all of the strips of kitchen paper to dry, then compare the results.

What do you see when you compare each pen? What colours do you see travel up the kitchen paper?



Pigments and dyes from different pens move different distances as the water moves up the strip of paper.

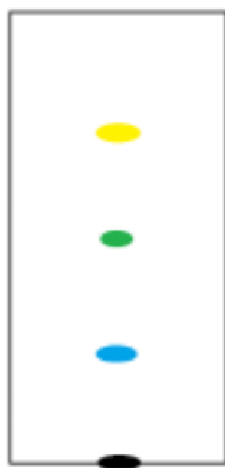
This is because some dyes **dissolve more easily in water than others!** Dyes that dissolve more easily in water will travel further up the paper with the water!

# Which pen was used to forge the fake nice list?



Find the matching ink profiles and help us find the culprit!

Chromatography of the ink used in the fake nice list

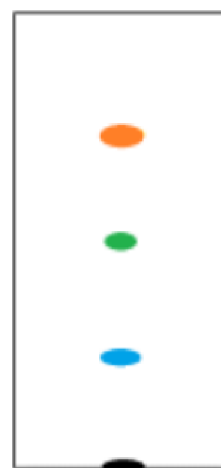


Ink profiles from pens found at the homes of 3 key suspects

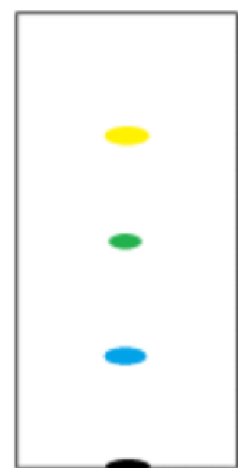
Pen 1



Pen 2



Pen 3



**Pen 1:** obtained from **Papa Elf**. Pen 1 is the standard pen used by elves in the workshop.



**Pen 2:** obtained from **Santa Claus**. Pen 2 is Santa's special fountain pen that he only uses for the naughty and nice lists.



**Pen 3:** obtained from an elf helper called **Twinkle Mittenbell**. Pen 3 is their personal fountain pen.

Witnesses state that Twinkle Mittenbell had recently been boasting of receiving a fancy new fountain pen from the South Pole. On the day of the crime Twinkle Mittenbell had also been seen using it in the workshop.

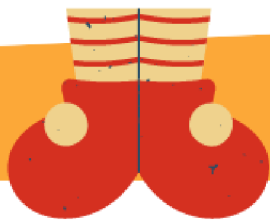


# Item 5: Footwear Mark



The North Pole Police found that the culprit walked through the office with powdered sugar on their shoes, leaving a **footwear mark** forensic scientists could recover and analyse!

Try recording your own footwear marks and see if you can identify some of the features that can make some footwear marks distinguishable from others.



## Activity: Footwear marks

Footwear marks, or shoeprints, are marks left by footwear when moving across a surface. They are one of the most common types of evidence investigators can find.

Forensic scientists can analyse a footwear mark to **help find the shoe** that may have been worn during the crime.

**NOTE:** To minimise the risk of slipping during this activity, work on a flat surface that is easily cleaned and tape down the test paper whenever possible.

### You will need:

- A pair of well-loved shoes, because they will get messy and you don't want to ruin your best shoes!
- Oil
- Hot chocolate powder
- Small paintbrush
- A4 paper
- Sticky tape



# Making Footwear Marks continued...



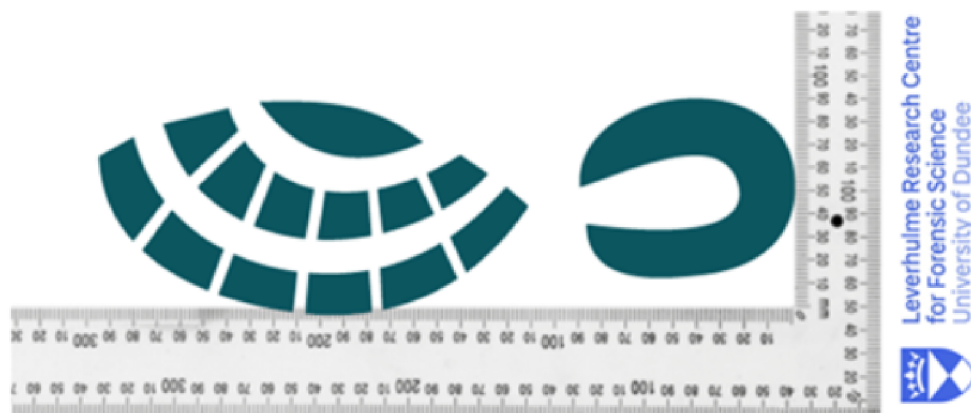
## Instructions

1. Lightly paint the bottom of your shoe sole with the oil – **don't use too much if you want a clear print!** If you use too much you can stand on a scrap piece of paper to remove excess oil.
2. Put on your shoe and stand on the paper in one smooth movement. Have a friend or family member nearby to help support you if you need it.  
**Don't forget to clean your shoes!**
3. If you can't see the mark, then brush some of the hot chocolate powder onto the print and that may help show it clearly. Blow away any excess powder.
4. **Repeat the experiment again with the same shoe and see if you get similar results.**



If you want to experiment further, you could try taking your footwear mark when **walking or jumping** to see if that changes how your shoeprint looks!

So they can better understand how footwear marks are made, forensic scientists need to collect many footwear marks made by the same shoe, to look at how marks can vary, e.g. does the mark from by the same shoe always look the same when walking?



# Match the Footwear Marks!

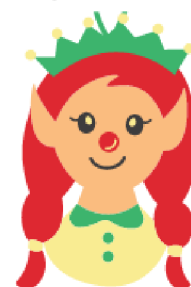
Now use your knowledge of footwear marks to identify which shoe left the footwear mark in Santa's Office!  
Our suspects were all spotted near the Office shortly before the crime!



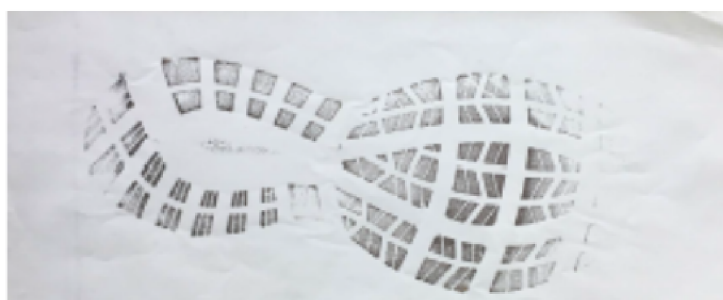
Footwear mark recovered from Santa's office



Berry Frostfoot



Twinkle Mittenbell



Choco Junglescarf

# Fingerprint Recovery



**Forensic scientists were able to recover a finger mark from Twinkle's pen...**



## Item 6: Fingerprint

The skin on your fingertips, palms and soles of your feet is different from the rest of your body. They are covered in little curved ridges that are not present on the rest of your skin. These 'friction ridges' form recognisable patterns we call fingerprints.

We leave fingerprints because our hands sweat and will also pick up substances like grease or other materials in daily life. When we touch a surface, those substances on our fingers get left behind along with an impression of the friction ridges.

Friction ridges develop randomly in the womb before birth and do not change over a person's lifetime. This means every person has different fingerprints, even identical twins!

This makes fingerprints good forensic evidence because trained and experienced fingerprint examiners can compare two fingerprint impressions to identify whether they may come from the same person.

**Try recording your own fingerprints and see if you can identify some of the features that make your fingerprints different to others!**





# Activity: Poring over Fingerprints

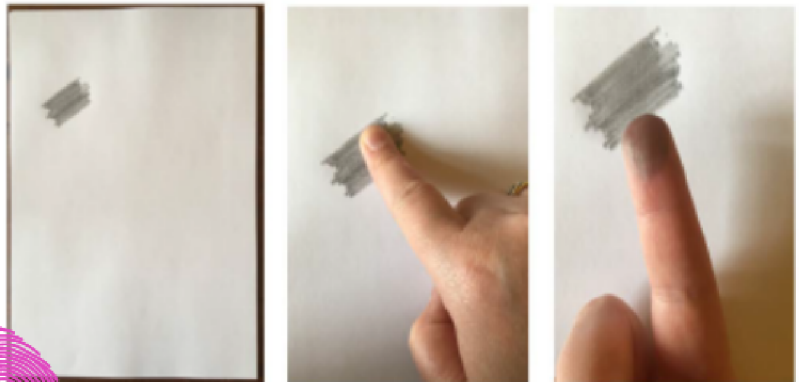


In this experiment, you will record and examine your own fingerprints to see what patterns make your prints different!

Don't forget to keep making notes!

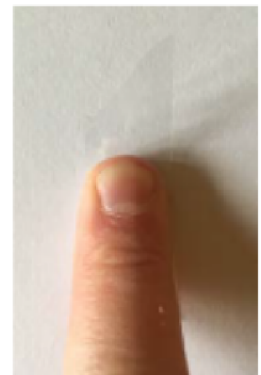
You will need:

- HB pencils
- Roll of Sellotape
- Sheets of A4 paper
- A magnifying glass



## Instructions

1. Using a HB pencil, scribble a round rectangular-like mark on the paper. You want it to be large enough to press your finger into.
2. Rub your fingertip across the pencil mark so that the graphite covers the skin on the underside of your finger.
3. Cut off a piece of Sellotape and press your graphite-covered finger into the sticky side.
4. Stick the Sellotape onto a clean A4 sheet of paper.
5. Repeat this for all of your fingers and thumbs. Keep track of which prints you have taken as you go!



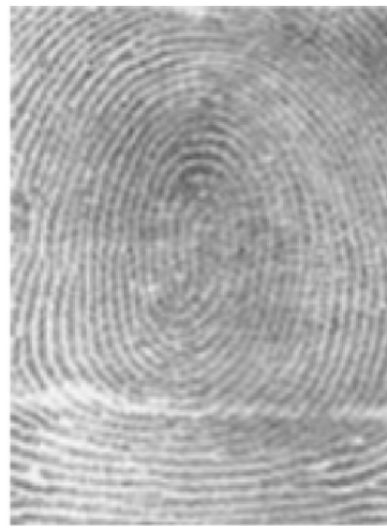
# Poring over Fingerprints continued...

Examine your fingerprints using your eyes or with a magnifying glass and try to spot the different shapes left by the ridges on your fingers.

The most common fingerprint patterns are Loops (60-70%), Whorls (20-35%) and Arches (5-10%)



Loop



Whorl



Arch



Now look at all of your other fingerprints and identify the patterns you can see. If you can – record the fingerprints from other people in your family and compare them to yours.

Can you see the differences?



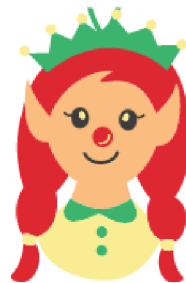
# Fingermark identification



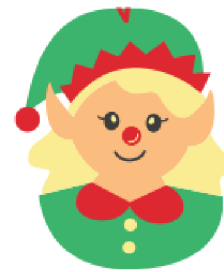
Using your knowledge of fingerprints can you identify who left the below fingermark on Twinkle Mittenbell's fountain pen?



**Choco Junglescarf**



**Twinkle Mittenbell**



**Berry Frostfoot**





# Notetaking



**Use these pages to record your observations**

Forensic scientists need to take detailed notes of their observations and analysis. This is important as they may need to answer questions about what they did in court. It is important to record the date, the item and your name.

Remember to also fill out this Mentimeter with your conclusions as you complete each activity!

[menti.com/alzkphi5fy9e](https://menti.com/alzkphi5fy9e)







# Notetaking

## Use these pages to record your observations

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# What did you find?

After being questioned in court, **Berry Frostfoot** admits they used Twinkle's pen to create a new nice list so they could add their name to the list. Berry knew that they would be moved to the naughty list for eating icing from the kitchen without asking first.



Berry apologises to Twinkle, Santa and all the other elves and said they realised their mistake. The real nice list was stored in the Reindeer hay outside in the stables.

**Thank you for helping to solve the crime and save Christmas!**

## Answers to the puzzles

1. Studying the skeleton: Age is adult
2. The crime scene: There are 6 differences
3. The fibres came from an elf and Santa's coat
4. The pen that made the fake nice list was the one owned by Twinkle Mittenbell
5. The shoe print was made by Berry Frostfoot's shoe
6. The fingerprint found on Twinkle Mittenbell was from Berry Frostfoot



# Well Done



Well done for completing all your activities and experiments, we've discovered more about forensic science!

You've done such a great job, thank you for joining us with your Forensic Science@Home Kit. We hope you had a blast doing the activities and becoming a forensic scientist!



Find and cut out your Forensic Science@Home certificate, write your name on it and give yourself a pat on the back.

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## WELL DONE!

Well done on completing the Forensic Science@Home Kits!

We hope you have had a blast doing science with us and getting stuck in with all the hands-on activities.

You've worked super hard and you are now a Dundee Science Centre Scientist!



Science@Home

This certificate is presented to



for completing Dundee Science Centre's Forensic Science@Home Kits!







In collaboration with: the University of Dundee Leverhulme Research Centre for Forensic Science and the Royal Institution



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for Forensic Science  
University of Dundee



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