FORENSIC CHEMISTRY:
FIRE SCENE INVESTIGATION

PhD. Marta Ferreiro González

CLIL - Content and Language Integrated Learning

marta.ferreiro@uca.es
- Bachelor’s degree
- Master’s degree
- Training courses for firemen, policemen, criminologists...
1. To understand the importance of Analytical Chemistry in Forensic Sciences.

2. To learn different applications of Forensic Chemistry.

3. To learn about fire scene investigation: arsons.
   1. Sampling techniques: detection of accelerants at fire scene.
   2. Analytical techniques for the detection and characterization of accelerants.
   3. Interpretation of the results.
Introduction to Forensic Chemistry

Fire Scene Investigation

Accelerants:
Analytical techniques

Accelerants:
Sampling techniques

Interpretation of the results
HOW MANY TYPES OF CRIME?

Assault  Rape  Murder

Terrorism  Burglary

Robbery  Vandalism

Highjacking

Kidnapping  Drug dealing

Food adulteration
Forensic chemistry is the application of analytical chemistry to the law and involves the examination of physical traces, such as body fluids, bones, fibres, drugs, fire debris, etc.

**Objective:**
- To develop fingerprints.
- To compare samples left at the crime scene, which **may be matched** to samples that are associated with the suspect.
- To develop databases with reference samples analyzed by a specific technique.

**Fingerprint comparison**

**DNA comparison**

**Ignitable liquids comparison**
CSI PORT ROYAL

Crimes

Drug dealing

Murder

Arson

Evidences

Fiber

Cocain

Blood

Hair

Gasoline

Tag
A disaster has occurred in CSI Port Royal. All the evidences have been mixed. Help Russel to analyze the different samples by the proper technique.
Think more analytical techniques that can be used for the analysis of the following evidences.
FIRE SCENE INVESTIGATION: ARSONS
Fire scene investigation, also referred to origin and cause investigation, is a specialized discipline of Forensic Sciences.

It is carried out mainly to answer the question of whether or not a crime has been committed and what the modus operandi of the perpetrator is.

The identification of victim(s) and perpetrator(s) is usually performed using a traditional criminalistics approach and does not concern the origin and cause investigation itself.
The goals of fire scene investigation are to answer the following questions:

- “Where did the fire start?” - refers to the determination of the origin of the fire
- “Why did the fire start?” - refers to the determination of the cause of the fire
Sort the different steps in fire investigation

- Fire investigator is summoned to the scene
- Collection of background information
- Examination of the scene
- Collection of evidence
- Laboratory examination of evidence
- Hypothesis developing and testing
- Conclusion and report writing
**DETERMINATION OF THE CAUSE OF THE FIRE**

- **Natural**
- **Accidental**
- **Deliberate**
- **Undetermined**

*Arson* is a **criminal** act of deliberately setting fire to a property

_in the spanish Criminal Code:_

“A conviction for arson of property that is not your own and that can cause a risk for persons is a felony punishable by up to **20 years** in state prison”

killing with cruelty- 20 years
Accelerants

Introduction

• An **accelerant** can be any material used to initiate a fire or increase the rate of growth or spread of a fire

• The most commonly used accelerants are **Ignitable Liquids, IIs.**

• The most commonly used ignitable liquids are **petroleum-based products**
Identidy Ingitable liquids in your lab and in your house.
IDENTIFICATION OF ACCELERANTS

Accelerants
Sampling techniques

Sampling
Analysis
Interpretation of the results

FIRE SCENE
LABORATORY
Accelerants: Sampling techniques
BUT ..........FROM WHERE?

Detection of accelerants in fire debris
Fire Scenes
Match the picture and the description to the corresponding technique.

The students will form 3 groups:

- Group A will have the pictures
- Group B will have the technique
- Group C will have the description

Group A: will show one of the picture, then, the second group will have to identify the technique and lately, the third one will have to say the description.

Group A will start and then group B, C....
ACCELERANT DETECTION CANINES

are an invaluable tool and are used to assist fire investigators in determining whether or not ignitable liquids (accelerants) were present at the time of a fire. They can also be used to detect ignitable liquids on a suspect’s clothing or inside of a vehicle used to transport such liquids, among other things.

IGNITABLE LIQUID ABSORBENT

consists of a powder that is designed to be spread onto a substrate and that has the capability of both absorbing ILR and indicating their presence.
COLORIMETRIC TUBES

Offer greater specificity to some chemicals than the electronic noses. These devices contain powder designed to react by changing color upon the presence of a specific chemical or class of chemicals.

ULTRAVIOLET DETECTION

Detect pour patterns of ignitable liquids at fire scenes has been reported as early as the mid 1970s.

BURN PATTERN OBSERVATION

“The visible or measurable physical effects that remain after a fire”
Accelerants: Analytical techniques
REFERENCE METHOD - Passive Headspace Adsorption ASTM E1412

Localization of accelerants → Sampling → VOCs Absorption → Desorption by CS₂

- GC-MS: TIC: 090712 GAS 166.D data.ms
- Time → Abundance
- Accelerants:
  - Analytical techniques
  - Localization of accelerants
  - Sampling
  - VOCs Absorption
  - Desorption by CS₂
HS-MS eNose with MS detector

Syringe

Mass spectrum

m/z

Accelerants

Analytical techniques

Oven
- T
- Agitation Speed
- Incubation time

Headspace Analysis VOCs

MS detector
Other analytical techniques

- Stir Bar Sorptive Extraction, SBSE
- Raman spectroscopy
- Solid Phase Microextraction, SPME
- Thin-layer Chromatography
- Second Derivative Ultraviolet Spectrometry
Interpretation of the results

Sampling → Analysis → Interpretation of the results

FIRE SCENE  LABORATORY
DATABASE GCMS

Interpretation of the results

Accelerants
The image shows a two-page spread with the following content:

**Right Page**

- **Title**: DATABASE
- **Graphs**:
  - Two graphs are present, each showing a time-abundance plot.
  - The X-axis represents time (in seconds) ranging from 0 to 26.00.
  - The Y-axis represents abundance ranging from 0 to 1.1e+07.

**Left Page**

- **Title**: Accelerants
- **Text**:
  - "Interpretation of the results" is written.
  - "Unknown sample" is highlighted.
- **Images**:
  - A question mark is present, indicating uncertainty or confusion.
  - A green check mark and a red X are used to denote correctness and incorrectness of interpretations.

**Central Panel**

- **Graphs**:
  - The graphs illustrate the analysis of two samples:
    - **TIC: 090512 GAS.D data.ms**
    - Sample 1: Toluene, n-pentane, n-octane, n-pentyltoluene, 1,2,4-trimethylbenzene
    - Sample 2: n-nonane, n-decane, n-undecane

**Overall**

- **Text**:
  - "GASOLINE 166" is mentioned, indicating the sample or the database name.
Word guessing party game

Option 1: The objective of the game is for a player to have their partners guess the word on the player's card without using the word itself or the additional words listed on the card.

Option 2: The objective of the game is for a player to have their partners guess the word on the player's card using the word itself or the additional words listed on the card.
Choose one person from a team to be the first clue giver. She/he sits opposite of their team and draws a card and starts the timer (2 min). The card should be hidden from their team but visible to at least one of her opponents. That opponent should hold the buzzer.

Give verbal clues to your teammates to help them guess the word printed at the top of the card. Your clues can be sentences or single words. Do not use the words that are printed on the Taboo list on the card. The list on the card contains a number of words or terms that are considered "taboo," and therefore cannot be said aloud by the clue giver. The listed words, and any parts or forms of them, are forbidden as clues. For instance, you cannot say the words "baby" or "sitter" if the word "babysitter" is listed. You also cannot say "work" if one of the words listed is "work".

Score one point for the clue giver’s team for each word they guess correctly. There is no penalty for wrong answers.

Award one point to the clue giver’s opponents for each time a Taboo word is used, and for each time the clue giver passes on a word.

Hit the buzzer if you hear the clue giver use the Taboo word. If this happens, the clue giver must move on to another word. The clue giver may continue giving clues until the time (one minute) expires.

The team with the biggest number of words guessed wins.
<table>
<thead>
<tr>
<th>Electronic Nose</th>
<th>Forensic Chemistry</th>
<th>Electrophoresis</th>
<th>Fingerprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headspace</td>
<td>Criminology</td>
<td>Gel</td>
<td>Match</td>
</tr>
<tr>
<td>Aroma</td>
<td>Sciences</td>
<td>Bands</td>
<td>Identify</td>
</tr>
<tr>
<td>Organic Volatile Compounds</td>
<td>Law</td>
<td>DNA</td>
<td>Impression</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GC-MS</th>
<th>Sampling</th>
<th>Accelerant</th>
<th>Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column</td>
<td>Evidence</td>
<td>Ignitable Liquids</td>
<td>Collection</td>
</tr>
<tr>
<td>Retention Time</td>
<td>Analysis</td>
<td>Gasoline</td>
<td>Website</td>
</tr>
<tr>
<td>Chromatogram</td>
<td>Scene</td>
<td>Arson</td>
<td>Fingerprint</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Arson</th>
<th>Evidence</th>
<th>Accelerant Detection Canines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crime</td>
<td>Crime</td>
<td>Dog</td>
</tr>
<tr>
<td>Fire</td>
<td>Scene</td>
<td>Animal</td>
</tr>
<tr>
<td>Deliberate</td>
<td>Prove</td>
<td>Police</td>
</tr>
</tbody>
</table>

**Forensic Chemistry**
- Criminology
- Sciences
- Law

**Electrophoresis**
- Gel
- Bands
- DNA

**Fingerprint**
- Match
- Identify
- Impression

**GC-MS**
- Column
- Retention Time
- Chromatogram

**Sampling**
- Evidence
- Analysis
- Scene

**Accelerant**
- Ignitable Liquids
- Gasoline
- Arson
Goals accomplished

1. To understand the importance of Analytical Chemistry in Forensic Sciences.
2. To learn different applications of Forensic Chemistry.
3. To learn about fire scene investigation: arsons.
   1. Sampling techniques: detection of accelerants at fire scene.
   2. Analytical techniques for the detection and characterization of accelerants.
   3. Interpretation of the results.
If you play with fire, you'll get burned

THANK YOU FOR YOUR ATTENTION
ELECTROPHORESIS

Drug dealing
Murder
Arson

Fiber
Blood
Gasoline
Tag

GC-MS
LUMINOL
FT-IR

Blood
Cocain

Forensic Chemistry

Analytical Technique

Crime
Evidence

TASK