Forensic chemistry or criminal chemistry is the branch of chemistry that specializes in studying crime and methods of detecting it and providing scientific evidence that helps in solving the case. It is also called criminal or judicial chemistry. Forensic chemistry is divided into

(A) (Forensic document examination chemistry).
(B) (Forensic poison, drug and blood chemistry).
(C) (Forensic tissue, thread, fire, projectile, gunshot and explosives examination chemistry).
(D) (Forensic fingerprint, footprint and car tire examination chemistry) .

Forensic chemistry is usually associated with crime scene analysis (the place where the crime occurred). The chemical analysis process includes the use of chemical analytical methods to analyze the mystery of many crimes, whether murder, bombings, theft, or any type of accident. Usually, the analysis identifies the origin of many of the chemicals used in the crime scene, and it also has many applications in various forensic sciences, including the field of counterfeiting and forgery, as banknotes are considered one of the most important documents exposed to forgery because they consist of the finest components of paper, inks and printing, in addition to the presence of means of guarantee that prevent their forgery.

A general definition of forensic chemistry can be put as: "The use of chemical analyses of various types on samples of physical traces in order to identify their nature, components and the extent of their belonging to a specific person and harnessing this to serve justice.

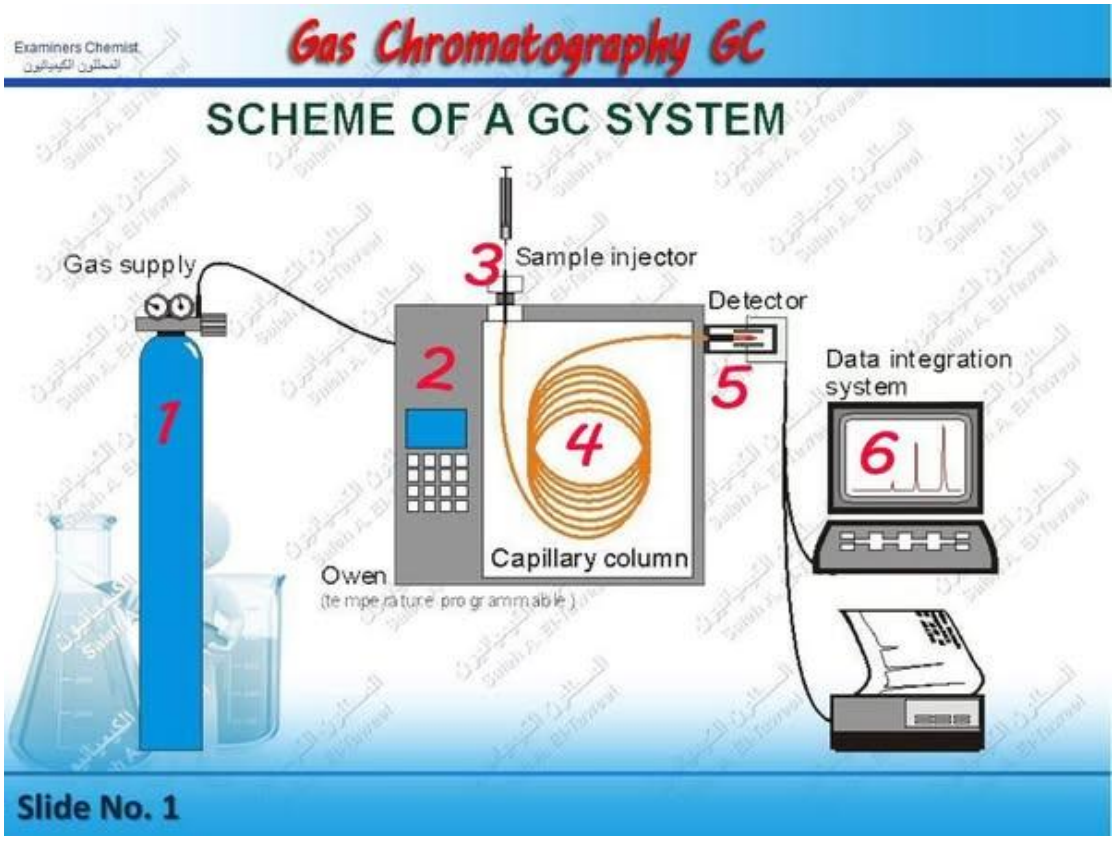
-One of the important devices used to examine fires, drugs and explosions is the GC-MASS device.

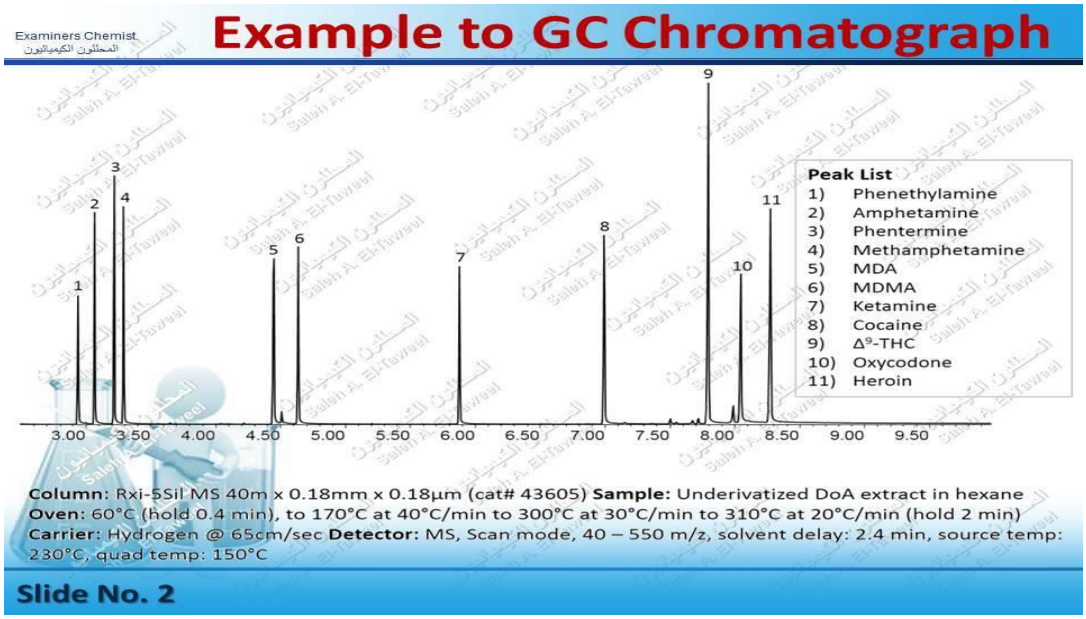
The device consists of five main areas.

1- **Gas system**: It consists of a gas cylinder containing helium He_2 gas, the carrier phase, and a gas regulator is connected to the cylinder to control the amount of gas transferred to the device, as well as a filter to get rid of oxygen, hydrogen and water.
2- **Injector**: The sample is transformed from a liquid to a gas due to the high temperature of the injector, then it enters the separation column carried by the mobile phase carrier gas. Injection is of two types: part of the sample is fissionable and non-fissionable injection, injection of the entire sample.
3- **The GC oven:** contains a separation column. The process of separating materials and compounds takes place inside the separation column. The sample components reach the detector during different time periods depending on the properties of the sample. The separation column is divided into two types: capillary columns and packed columns.

4- **Mass detector**: The sample components reach the detector, and the signal resulting from the collision of the ions with the detector is converted into diamonds that appear on the computer screen.

5- **Electronics:** is the computer system that reads the results of separating the sample components and appears in the form of diamonds (curves) on the computer screen depending on the time and concentration of the sample components. The computer contains a library of chemical compounds and through the shape of the different diamonds it is possible to know the type of material.







Gas chromatography results in GC-mass analysis:

As mentioned earlier, to perform a chromatographic analysis, a solution of the desired sample (liquid or gas) is first injected into the hot chamber of the injector using a micro-injector (for a liquid sample) or a gas syringe (for a gas sample). The sample components evaporate rapidly when they come into contact with the high temperature of the injector.

Then, with the flow of the carrier gas, they are directed to the column inside the vessel at an adjustable temperature. Each component of the sample interacts separately with the stationary phase inside the column. The speed of movement of

the components along the column varies due to the difference in the amount of interaction of each component with the column.

The amount and type of interaction of each component with the stationary phase depend on this, and the speed of its movement, in addition to the intrinsic nature and chemical composition of the species, depends on the type of stationary phase, the flow rate of the carrier gas and the temperature of the oven.

After any part of the column leaves and reaches the detector, an electrical signal occurs whose intensity is proportional to the amount of this part. The generated electrical signal is sent to the chromatography machine and the results are calculated, and the final result is obtained in the form of a chromatogram.

A chromatogram is a graph in which the detector responses to sample components are plotted according to the time at which the components leave the column (load time). Each chromatogram contains several peaks, each peak belonging to a single component of the sample.

Uses of GC-mass analysis in the field of crimes and forensic evidence:

One of the important uses of GC MASS analysis is in the field of forensics and criminology. Uses such as the analysis and investigation of suspicious samples discovered at a crime scene, the investigation of remains resulting from fires, the detection of doping in athletes' bodies through urine tests, as well as the finding of toxins and doping in biological samples of suspects and victims, etc

Steps to operate the GC-Mass device:

1-Open the gas cylinder and then open the gas regulator.

2- Open the calculator until the calculator screen appears, which contains the GC-Mass program opening icon..

3- Open the calculator until the GC-Mass program appears.

4- Open the icon to operate the GC-Mas device.

5- Until the temperature stabilizes, we prepare the sample.

6- The sample is dissolved in a suitable solvent. If it is a poison or drug, it is dissolved in methanol (CH3OH). If the sample is fire waste or petroleum products, it is dissolved in DCM dichloromethane (CH2Cl2). If it is an explosive product, the solvent used is acetone nitrile.

7- We prepare the solvents (A) and (B) found in the injector part. If the sample is drugs, then solvent A will be hexane and solvent B will be methanol. However, if the sample is fire residue, then hexane will be solvent A and DCM will be solvent B. As for explosive materials, acetone nitrile will be solvent B.

8- Solvent B in all samples is the same solvent used for the sample in the preparation stage and is the same solvent used for washing before injection to prevent contamination.
9- After preparing the sample and washing solutions, we go to the program and choose the method, then run.

The principle of operation of the device:

The working principle in preparing samples depends on the adsorption of vapors rising from the sample on the surface of the activated carbon samples according to Lockhart's theory, which states that (when two bodies come into contact with each other, a transfer of part of both materials will occur to the other. The amount of the transferred material varies depending on the temperature, hardness, and the gaseous, liquid, or solid state of the material.