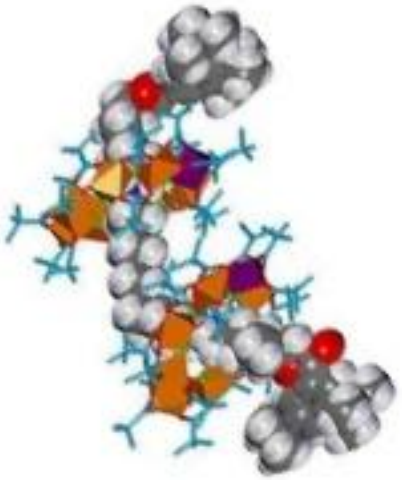
Instrumentation

Suman Dua

4. TESTED SAMPLES



Two main classes of chemical compounds,

Organic compounds

- Are based on carbon
  and are found in living things.

Inorganic compounds

- Are those based on other elements.
- From the point of view of forensic science, both organic and inorganic compounds are found in items of evidence.
- The techniques used for determination of chemical composition of such evidence often depend upon whether the component compounds are organic (derived form living tissue or material) or inorganic.

Forensic Laboratory

TESTED SAMPLES

Biological samples include:

- Blood,
- Urine,
- Hair,
- Nails,
- Saliva,
- Tissues and
- Exhaled breath.

Non-biological samples include:

- Unidentified pills,
- Powders,
- Liquids,
- Gases.

Forensic Laboratory

NON-BIOLOGICAL SAMPLES

Broad classes of substances frequently found in post-mortem investigations

Gases and volatiles	Acids	Neutrals	Bases	Metals
Alcohols, chlorinated hydrocarbons, aromatic hydrocarbons, carbon monoxide, cyanide	Barbiturates, salicylates, paracetamol (acetaminophen)	Glutethimide, ethchlorvynol, meprobamate, carisoprodol	Cocaine, propoxyphene, opium alkaloids, antidepressants, benzodiazepines	Heavy metals

BIOLOGICAL SAMPLES FOR TOXICOLOGICAL ANALYSIS

Type	Quantity	Analysis
Blood (heart, femoral)	20 ml	Volatiles, drugs
Urine	20 ml	Drugs, heavy metals
Bile	20 ml	Narcotics, other drugs
Kidney	Entire	In absence of urine
Liver	20 g	Many drugs
Gastric contents	Total	Drugs taken orally
Vitreous humor	Both eyes	Alcohol, glucose, drugs and electrolytes

PATHOLOGICAL OBSERVATIONS & POSSIBLE POISONING

Pathological observation	Possible cause
Burns around mouth, lips, nose	Acids
Skin of face and neck quite dark	Aniline, nitrobenzene
Severe, unexplained diarrhea	Metals (arsenic, mercury, copper, etc.)
Pupil of eye dilated	Atropine (Belladonna), Scopolamine
Burns around mouth, lips, nose	Bases (lye, potash, hydroxides)
Odor of disinfectant	Carbolic acid or other phenol
Skin is bright cherry red	Carbon monoxide
Quick death, red skin, odor of peach	Cyanide
Vomiting, abdominal pain	Food poisoning
Diarrhea, vomiting, abdominal pain	Metallic compounds
Convulsion	Nicotine
Odor of garlic	Oxalic acid, phosphorous
Convulsion	Sodium fluoride

5. METHODS OF ANALYSIS

- All methods are standard methods.
- The selected methods will be suitable for Lab samples.
- Reference for all methods.
- QC applications for Methods of analysis.

Forensic Laboratory

6. INSTRUMENTS

All the required instruments chosen according to:

- Test methods.
- Up to date version.
- Good reputation instrument manufactures.
- Technical Comparisons results between suppliers.

Forensic Laboratory

6. INSTRUMENTS

All the required instruments chosen according to:

- Test methods.
- Up to date version.
- Good reputation instrument manufactures.
- Technical Comparisons results between suppliers.

Forensic Laboratory

REQUIRED INSTRUMENTS

- There are thousands of possible substances that could be encountered in poisoning or drug overdose cases and millions of possible substances that could be found in non-biological samples.
- There are techniques for the analysis of almost all of these, but without a short list of possible agents it would be a very difficult task to decide what to look for and what technique to use.

Forensic Laboratory

ANALYTICAL TECHNIQUES

- Some of the more common analytical techniques used in forensic toxicology

Compound	Sample nature	Method
Gases & Volatile Compounds	Simple mixtures, known compounds	**GC**
"	Complex mixtures, unknown compounds	**GC / MS**
Non-volatile organic compounds	Simple mixtures, known compounds	**HPLC**
"	Complex mixtures, unknown compounds	**LC / MS**
Toxic Metals		**AAS / ICP**

MAIN INSTRUMENTS

MAIN INSTRUMENTS

All the required instruments chosen according to test methods:

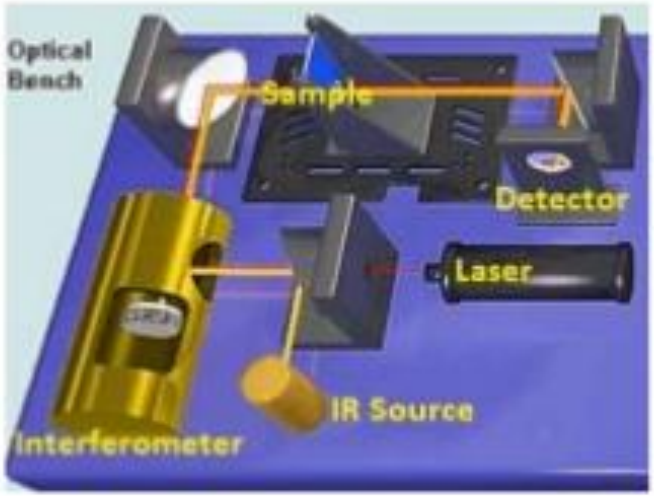
1. FTIR.
2. GC/MC.
3. LC/MS
4. HPLC
5. Microscope.
6. Atomic Absorption.
7. ICP - ICP/MS
8. Others instruments.

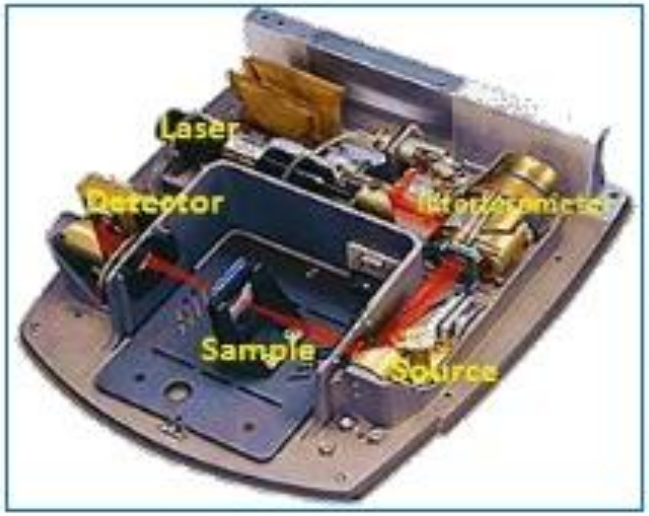
Forensic Laboratory

1. FOURIER TRANSFORM INFRARED

- FTIR Spectroscopy is a molecular spectroscopy which is used to characterize both organic and inorganic evidence.
- The sample is bombarded with infrared radiation.
- When the frequency of the infrared radiation matches the natural frequency of the bond, the amplitude of the vibration increases, and the infrared is absorbed.
- The output of an infrared spectrophotometer is a charts.

FTIR MAIN PARTS

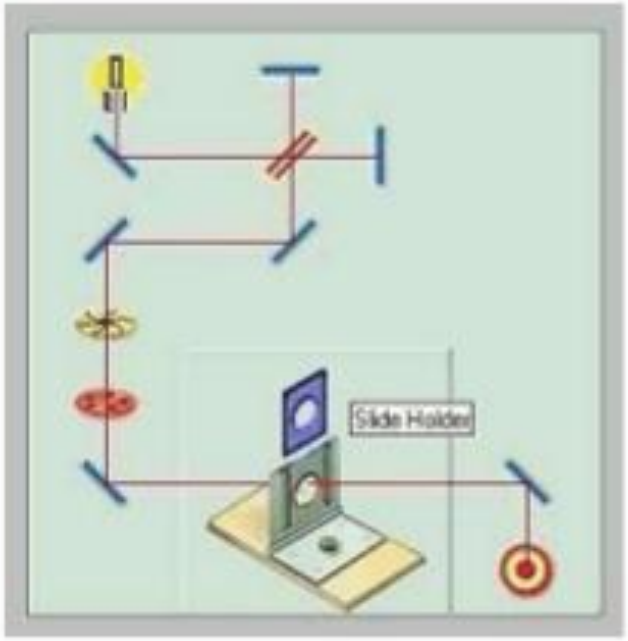




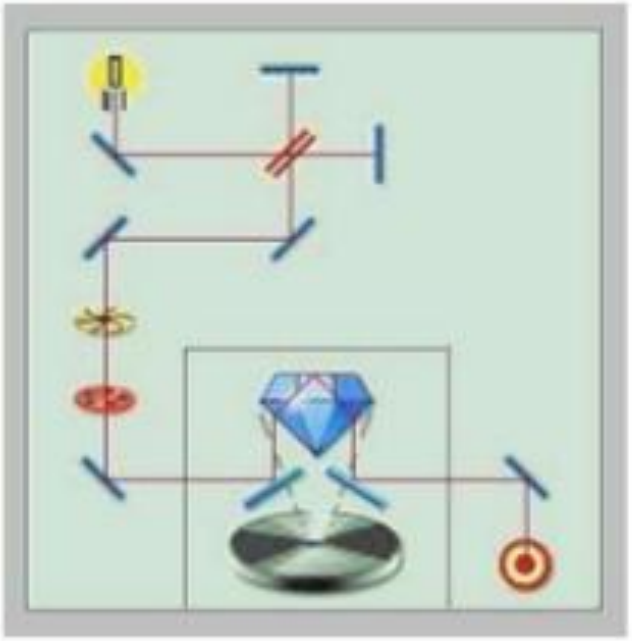
Forensic Laboratory

SAMPLE PREPARATIONS

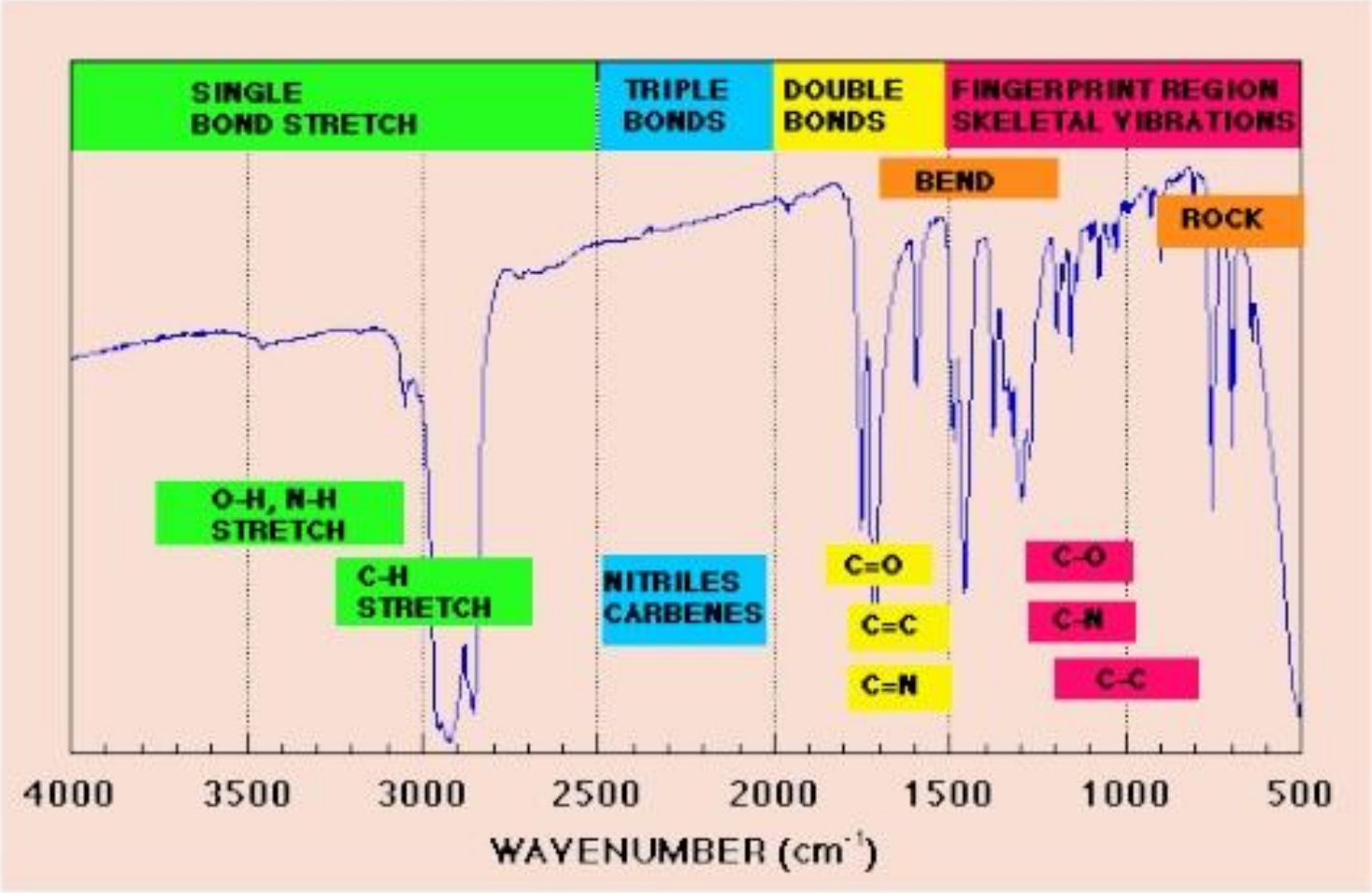
- Transmission



- Reflectance



FTIR CHART



Forensic Laboratory

FTIR APPLICATIONS

FTIR is a valuable forensic technique because of its detection sensitivity and versatility.

Chemicals from a variety of sample types including :

- Blood,
- Paints,
- Polymer coatings,
- Drugs and
- Both organic and inorganic contaminants can be identified

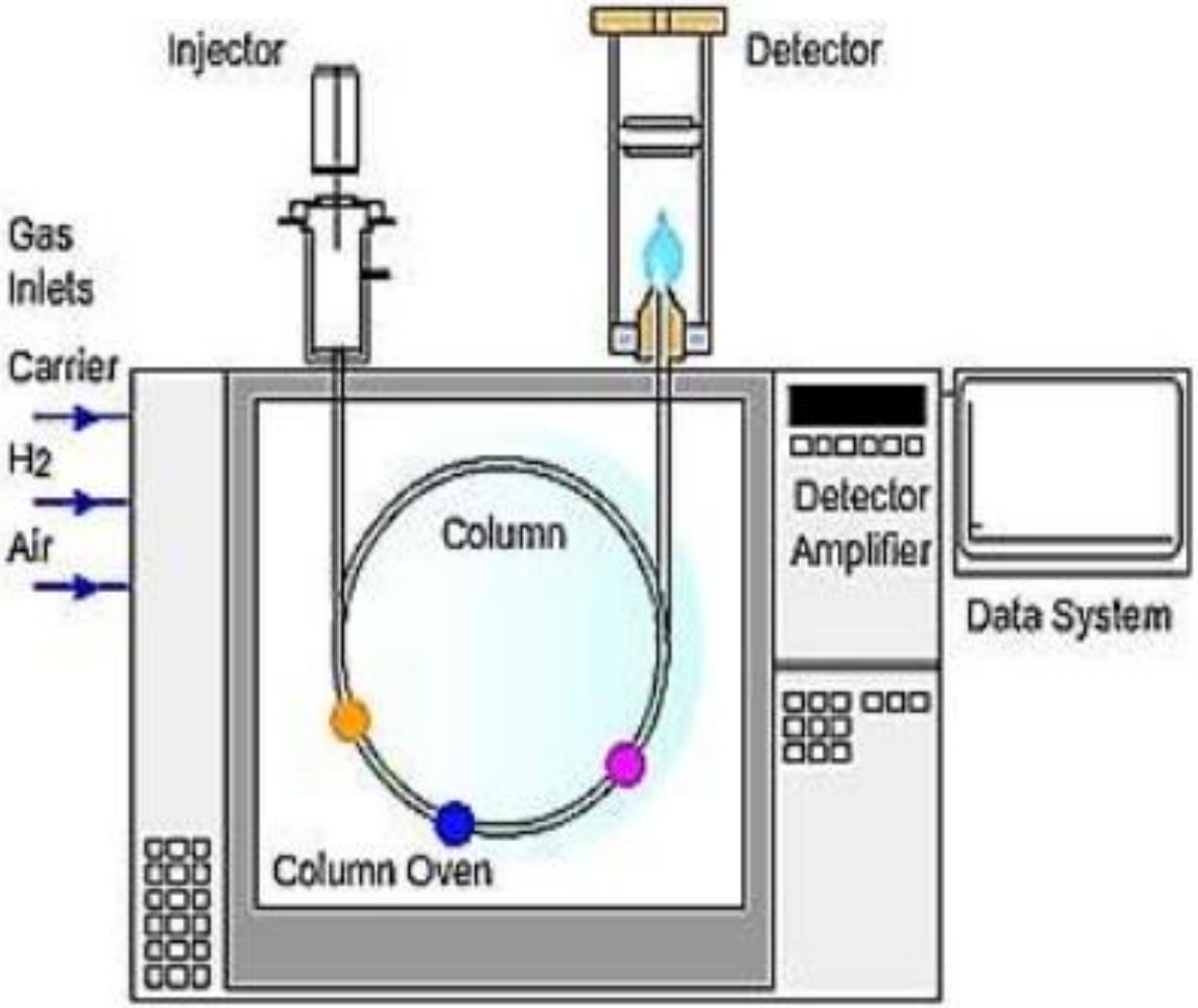
2. GC/MS

The GC/MS is comprised of two parts:

- The gas chromatograph / the mass spectrometer.
- The gas chromatograph functions by separating the molecules within the sample compound into their most elemental particles, allowing some types of molecules to pass into the mass spectrometer more rapidly than others.
- When the molecules move into the mass spectrometer, they are broken down into ionized fragments, and then each molecule is specifically identified based on mass and ionic charge.

Forensic Laboratory

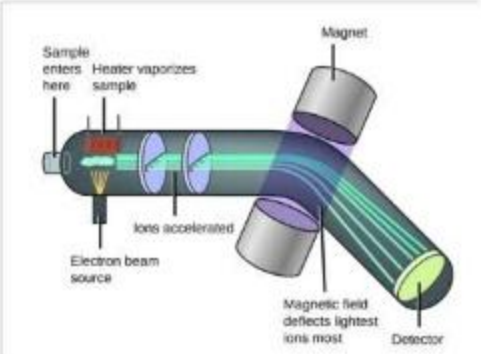
GC MAIN PARTS



Forensic Laboratory

MS MAIN PARTS

1. A small sample of compound is ionized, usually to cations by loss of an electron.
2. The ions are sorted and separated according to their mass and charge.
3. The Mass Analyzer to separated ions are then detected and tallied, and the results are displayed on a chart.
4. The Detector



Forensic Laboratory

GC / MS APPLICATIONS

Forensic applications of GC/MS include identification and detection of :-

- Explosives,
- Investigations of arson,
- Fire, and blasts or explosions,
- Environmental analysis,
- And drug detection.

Forensic Laboratory

3. LC/MS

- In LC-MS, there has been an explosion in the range of new products available for solving many analytical problems, particularly those applications in which non-volatile, labile and/or high molecular weight compounds are being analyzed.

Forensic Laboratory

LC/MS APPLICATIONS

- LC-MS is a well-established technique for explosives in associated complex matrices such as post-blast residues and in environmental samples such as soil and plant material extracts.
- LC-MS to enable unambiguous differentiation
- between structurally related textile dyes which were previously indistinguishable by UV-VIS absorption profile or by micro spectrophotometry.

Forensic Laboratory

4. HPLC

- High-performance liquid chromatography (HPLC; formerly referred to as high-pressure liquid chromatography),
- Is a form of liquid chromatography where the high pressure used to separate the mixture components, then identify, and quantify

Forensic Laboratory

HPLC MAIN PARTS

HPLC instruments consist of:

1. Solvent rack,
2. Pump,
3. Injector,
4. Separation column,
5. Detector.

Forensic Laboratory

HPLC APPLICATIONS

Some of the most popular applications to evidence analysis are:-

- Drugs
- Soils
- Inks
- Explosives

Forensic Laboratory

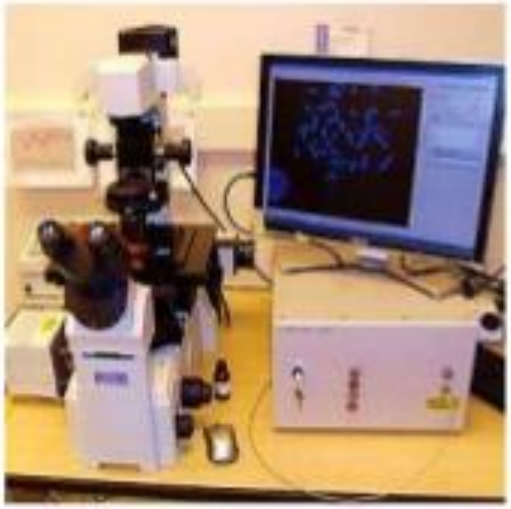
5. VISIBLE MICROSCOPE

- Visible microspectrophotometry is a very useful tool in the forensic analysis of many kinds of trace evidence.
- It combines a microscope with a spectrophotometer so that the light absorption properties of a very small sample can be recorded.

VISIBLE MICROSCOPE APPLICATIONS

The technique is particularly valuable in the investigation of:-

- Hair,
- Textile fibers,
- Paint,
- Colored inks



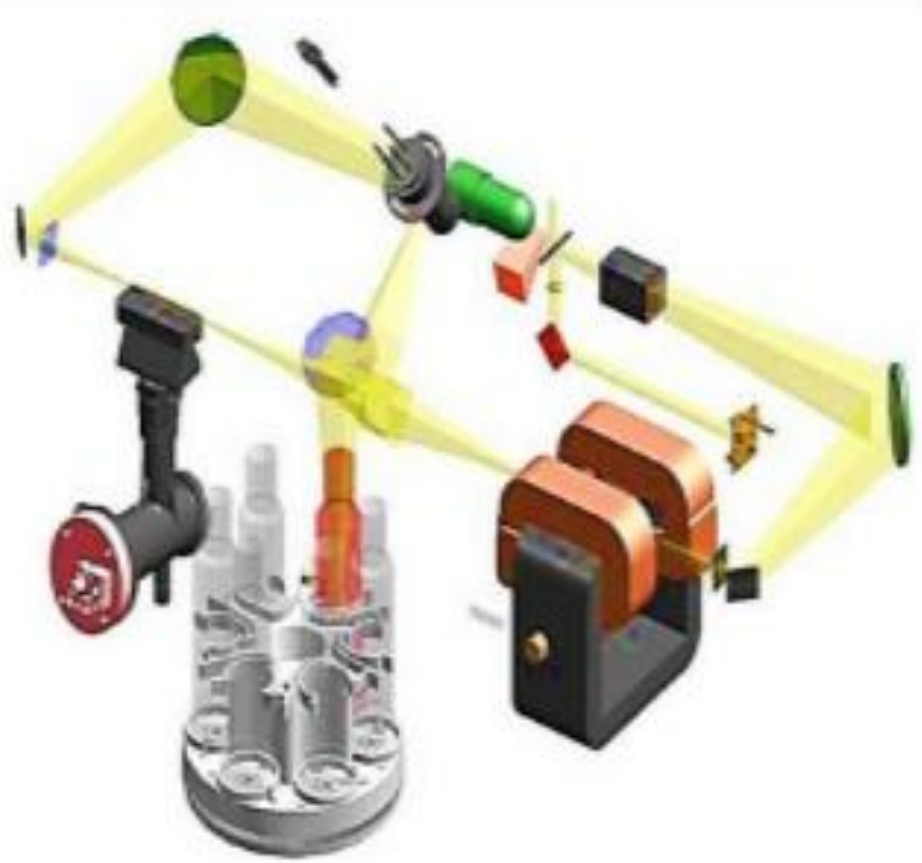
which are typically of microscopic dimensions.

A fiber, for instance, may have a diameter of only around 20 micrometers.

Forensic Laboratory

AA MAIN PARTS

- Lamp
- Atomizer
- Monochromator
- Photomultiplier tube
- Optical system
- Automatic gas control



Forensic Laboratory

IDENTIFICATION OF A POISON

- Qualitative Analysis of an Inorganic Compound
- A poison is a substance that can cause, to an organism, injury, illness or death when a sufficient quantity is present.
- This indicates that any chemical substance in sufficient quantities can act as a poison even table salt.

HEAVY METALS TOXICITY

- There are 35 metals that concern us because of occupational or residential exposure; 23 of these are the heavy elements.
- Or "heavy metals": antimony, arsenic, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thallium, tin, uranium, vanadium, and zinc .
- Interestingly, small amounts of these elements are common in our environment and diet and are actually necessary for good health, but large amounts of any of them may cause acute or chronic toxicity (poisoning).

ATOMIC ABSORPTION APPLICATIONS

Forensic and clinical applications

- Blood, urine, serum, tissue, bone and hair, Al, Cr, Cu, Zn, As, Se, Cd, Pb, Hg
- Some elements toxic Al, As, Cd, Hg, Pb
- Some essential Se, Fe, Zn, Cr
- Some vital at low levels, toxic if high Cu, Zn, Se

Forensic Laboratory

ICP- AES

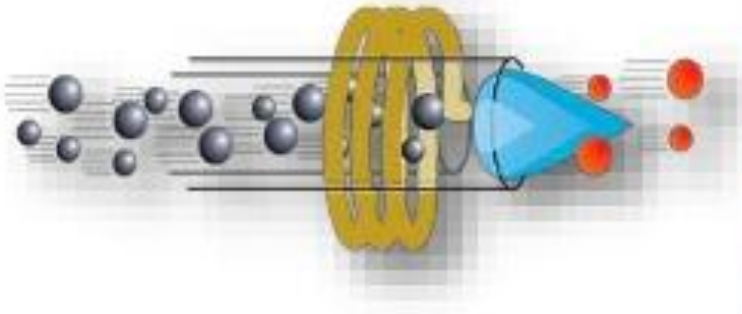
Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES),

- It is a multi-element analysis technique that will dissociate a sample into its constituent atoms and ions and exciting them to a higher energy level.
- Cause them to emit light at a characteristic wavelength , which will be analyzing

ICP TECHNIQUE

Steps

- Plasma will dissociate a sample into atoms , ions.
- Exciting them to a higher energy level.
- Atoms and ions emits light at a characteristic wavelength .
- The emitted light, will be analyzing .



The instrument will know the concentration of metals inside the sample, using standard solutions.

THE FUNCTIONAL PARTS OF ICP

The iCAP 7000 spectrometer consists of several major components:

- Sample introduction parts. Plasma torch.
- Gas control.
- Radio frequency power generator.
- Optical system; Polychromator.
- CID detector with thermoelectric cooling.
- Interlocks.

ICP APPLICATIONS

- Environmental Analyses Applications
- Petrochemical Analyses
- Metallurgical analyses
- Geological analyses
- Foodstuffs analyses
- Forensic applications.

7. OTHER INSTRUMENTS

- UV-VIS spectroscopy .
- Polarizing light microscopy.
- Atomic Force Microscopy (AFM).
- X-Ray Photoelectron Spectroscopy (XPS).
- Thin layer chromatography .
- Scanning Electron Microscope (SEM).
- Polymerase chain reaction PCR.