Drugs II: Laboratory Analysis-B

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FORENSIC SCIENCE PROGRAM

TRENT UNIVERSITY

Reminders

FINAL EXAM:

Sunday April 19, 2020 11:00 AM- 2:00 PM

Lecture Order Change

Mar 2, 5 Drugs 2 (Ch11), Forensic Toxicology (Ch 12)

Mar 9,12 Bloodstain pattern analysis (Ch10); Fire Investigation (Ch 16)

Mar 16, 19 Guest lecture Entomology; Biological Stain Analysis: DNA (Ch 15)

Mar 23, 26 Biocrime / Microbial Forensics

Overview Today's Lecture

Reminder of drug classes

Canadian drug laws

Drug offense penalties

Introduction to crime scene collection of drugs

Drug identification

- Preliminary analysis
- Chromatography
- Spectrophotometry

Drug Classes From Last lecture

Opiates - Morphine, heroin, fentanyl etc.

Hallucinogens -THC, LSD, mescaline, PCP, psilocybin, and MDMA (Ecstasy), ergot alkaloids, mushroom ID

Depressants - Alcohol (ethanol), barbiturates, tranquilizers, and various substances that can be sniffed

Stimulants - Amphetamines, cocaine

Club Drugs - MDMA, GHB, Rohypnol, ketamine, and methamphetamine

Anabolic Steroids

http://laws-lois.justice.gc.ca/eng/acts/C-46/page-95.html

illicit drug means a controlled substance or precursor the import, export, production, sale or possession of which is prohibited or restricted pursuant to the *Controlled Drugs and Substances Act*

illicit drug use means the importation, exportation, production, sale or possession of a controlled substance or precursor contrary to the *Controlled Drugs and Substances Act* or a regulation made under that Act"

Controlled Drug and Substances Act, see the Justice Laws Website: http://laws-lois.justice.gc.ca/eng/acts/C-38.8/

Criminal Offence Penalty Chart (Limited Examples)

S=Summary H=Hybrid I=Indictable

Offence description	Controlled Drugs and Substances Act Section	S/H/I	Minimum penalty	Discharge available	Maximum Penalty (S)	Maximum Penalty (I)
Unauthorized possession in public by adult of cannabis (amount equivalent to over 30 gm of dried cannabis)	8(1)(a)	H		yes	6 mos./ $5,000 fine	5 yrs. less a day
Possession by adult of cannabis they know is illicit	8(1)(b)	H		yes	6 mos./ $5,000 fine	5 yrs. less a day
Possession of amphetamines, LSD, mescaline, or psilocybin	4(1)	H		yes	6 mos./$1,000 - 1st offence; 1 yr./$2,000 subsequent offence	3 yrs.

http://www.defencelaw.com;
Courtesy of www.defencelaw.com, website of Toronto criminal lawyer **Ron Jourard**. Telephone: (416) 398-6685; toll free (Canada and U.S.) 1-888-257-0002; email: jourard@defencelaw.com.

Collection and Preservation of Drug Evidence

The field investigator has the responsibility of ensuring that the evidence is properly packaged and labeled for the laboratory.

Generally common sense is the best guide, keeping in mind that the package must prevent the loss of the contents and/or cross-contamination. Often the original container in which the drug was seized will suffice.

All packages must be marked with information that is sufficient to ensure identification by the officer in the future and establish the chain of custody.

To aid the drug analyst, the investigator should supply any background information that may relate to a drug's identity.

Drug Identification

The challenge or difficulty of forensic drug identification comes in selecting analytical procedures that will ensure a specific identification of a drug.

The plan, or scheme of analysis, is divided into two phases.

- Screening tests that are nonspecific and preliminary in nature, they reduce the possible drug IDs to a manageable number.
- Confirmation tests that are single tests that specifically identify a substance.

Preliminary Analysis

Faced with the prospect that the unknown substance may be any one of a thousand or more commonly encountered drugs, the analyst must employ screening tests to reduce these possibilities to a small and manageable number.

This objective is often accomplished by subjecting the material to a series of color tests that will produce characteristic colors for the more commonly encountered illicit drugs.

Microcrystalline tests can also be used to identify specific drug substances by studying the size and shape of crystals formed when the drug is mixed with specific reagents.

Confirmational Determination

Once this preliminary analysis is completed, a confirmational determination is pursued.

Forensic chemists will employ a specific test to identify a drug substance to the exclusion of all other known chemical substances.

Typically infrared spectrophotometry or gas chromatography-mass spectrometry is used to specifically identify a drug substance.

Qualitative vs. Quantitative

Another consideration in selecting an analytical technique is whether a qualitative or a quantitative determination is required.

The former relates just to the identity of the material, whereas the latter requires the determination of the percent composition of the components of a mixture.

Chromatography

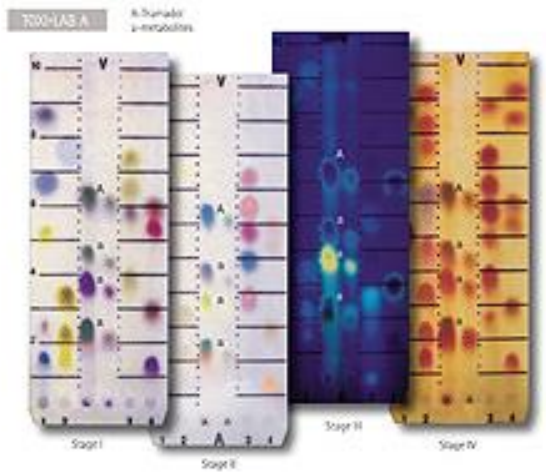
Chromatography is a means of separating and tentatively identifying the components of a mixture.

The theory of chromatography is based on the observation that chemical substances have a tendency to partially escape into the surrounding environment when dissolved in a liquid or when absorbed on a solid surface.

Those materials that have a preference for the moving phase will slowly pull ahead and separate from those substances that prefer to remain in the stationary phase.

Thin Layer Chromatography

TLC uses a solid stationary phase usually coated onto a glass plate and a mobile liquid phase to separate the components of the mixture.



- The liquid will slowly rise up the plate by capillary action causing the sample to become distributed between the solid stationary phase and the moving liquid phase.
- Because most compounds are colorless, the materials must be visualized by placing the plates under ultraviolet light or spraying the plate with a chemical reagent.
- The distance a spot travels up a thin-layer plate can be assigned a numerical value known as the R_f (rate of flow) value.

TLC Chambers

http://www.mn-net.com/tabid/5574/default.aspx

Gas Chromatography (GC)

http://www.chem.agilent.com

In GC, the moving phase is a gas called the carrier gas, which flows through a column.

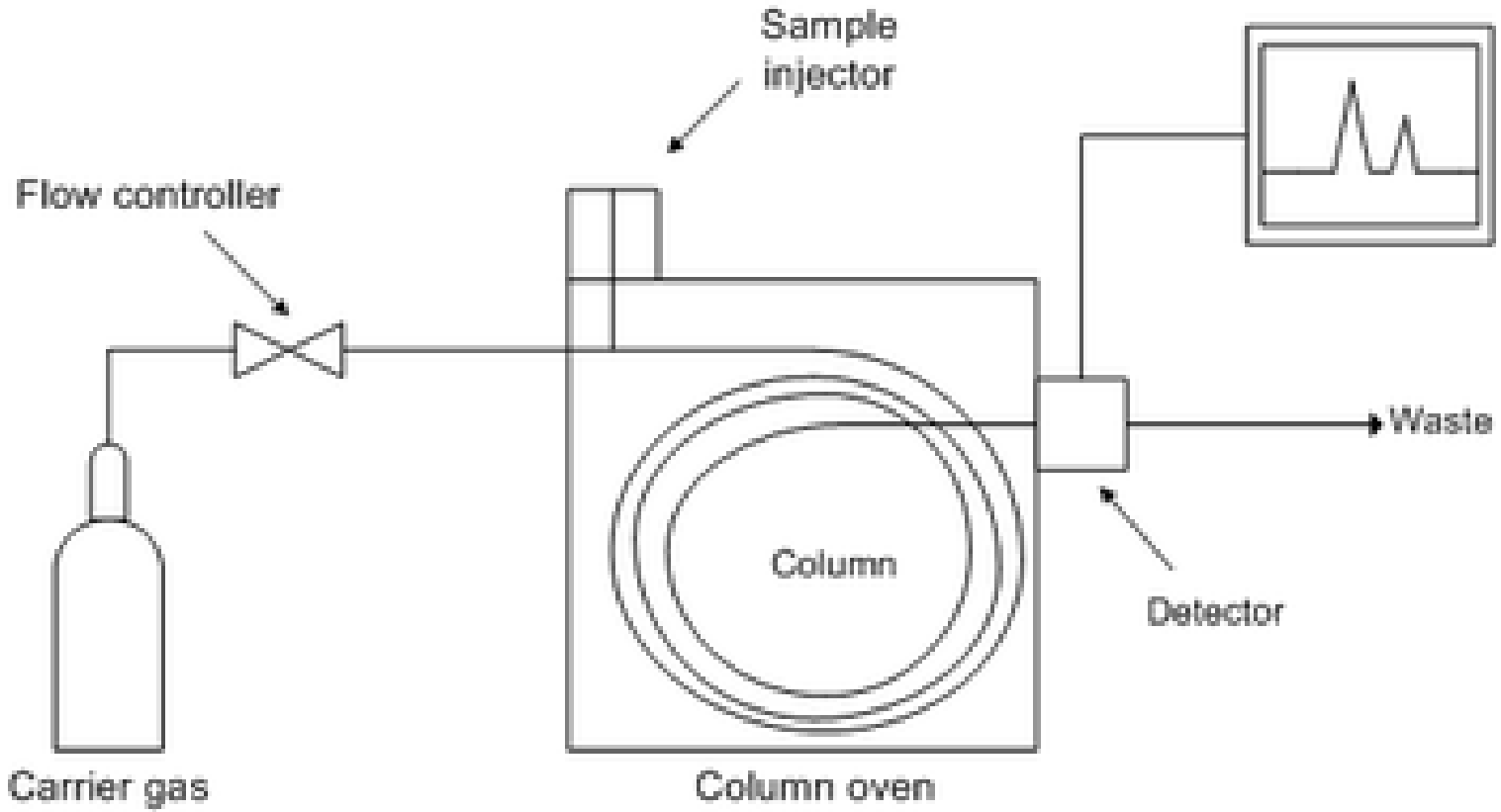
The stationary phase is a thin film of liquid contained within the column.

After a mixture has traversed the length of the column, it will emerge separated into its components.

The written record of this separation is called a chromatogram.

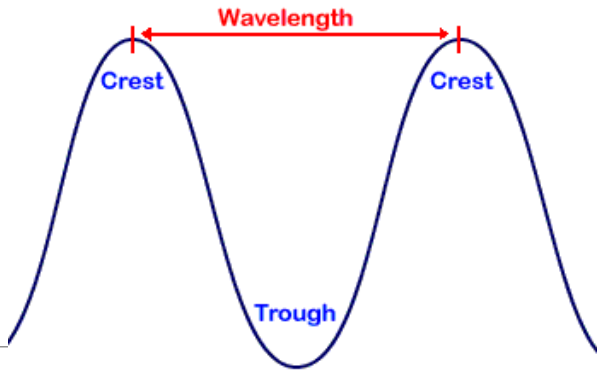
The time required for a component to emerge from a GC column is known as retention time.

Gas Chromatograph



http://en.wikipedia.org/wiki/Gas_chromatography

Theory of Light



Light is described as a continuous wave.

When white light passes through a prism, it is dispersed into a continuous spectrum of colors.

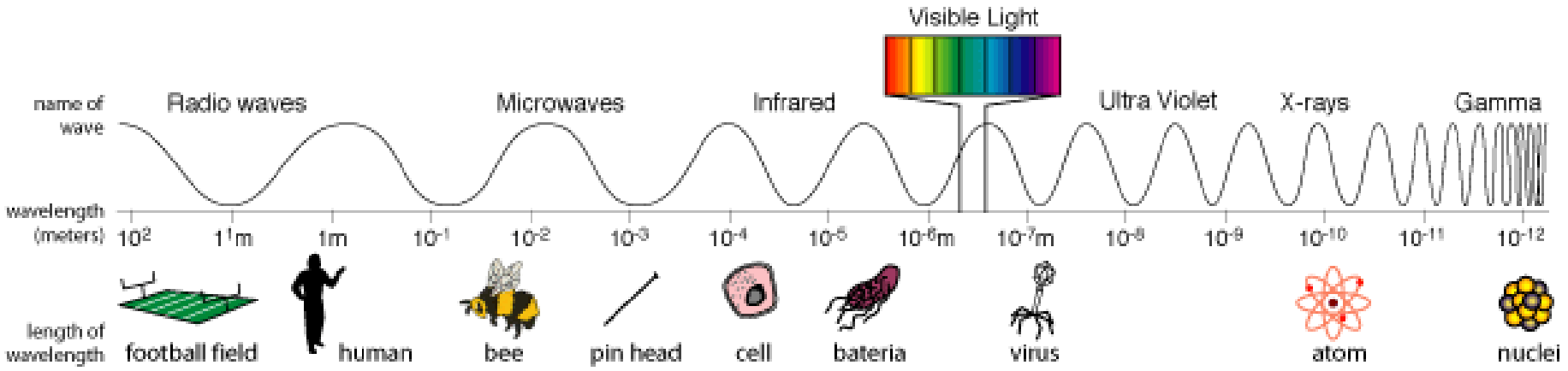
Waves are described in terms such as:

- Wavelength, the distance between two successive crests (or one trough to the next trough).
- Frequency, the number of crests (or troughs) passing any one given point per unit of time.

Light Continued

The electromagnetic spectrum is the entire range of radiation energy from the most energetic cosmic rays to the least energetic radio waves.

- Visible light is only a small part of the electromagnetic spectrum.

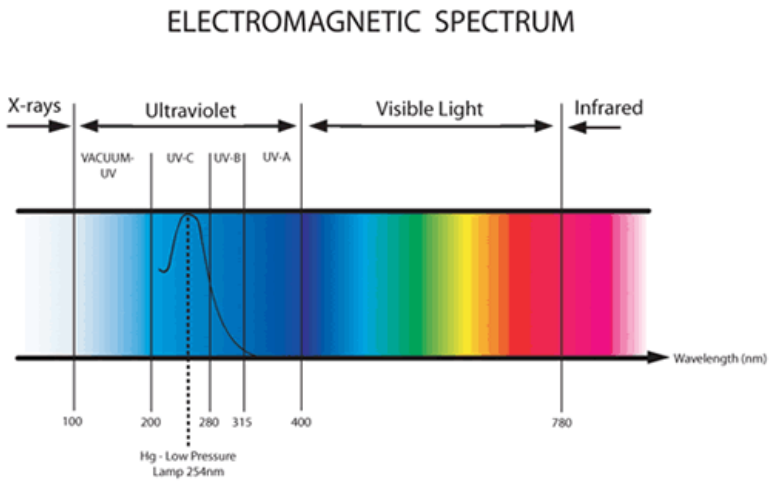


Images from: http://science.hq.nasa.gov/kids/imagers/ems/waves3.html

Spectrophotometry*

Just as a substance can absorb visible light to produce color, many of the invisible radiations of the electromagnetic spectrum are likewise absorbed.

Spectrophotometry, an important analytical tool, measures the quantity of radiation that a particular material absorbs as a function of wavelength and frequency.



http://uvspectrophotometer.net/uv-visible-spectroscopy/

The Spectrophotometer

Beckman Spectrophotometer, Model DU-530

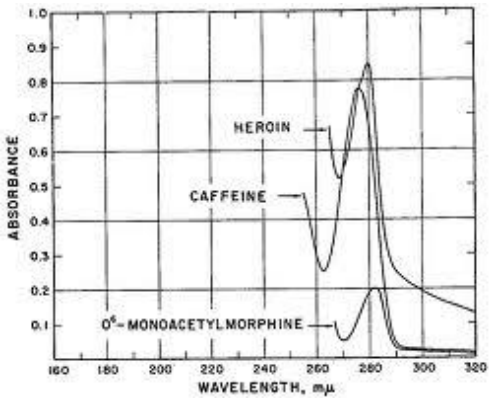
The spectrophotometer is the instrument used to measure and record the absorption spectrum of a chemical substance.

The components of a spectrophotometer are:

- A radiation source
- A monochromator or frequency selector
- A sample holder
- A detector to convert electromagnetic radiation into an electrical signal
- A recorder to produce a record of the signal

Absorption spectra can be recorded for the visible, ultraviolet (UV) or infrared (IR) regions.

UV and IR Spectrophotometry



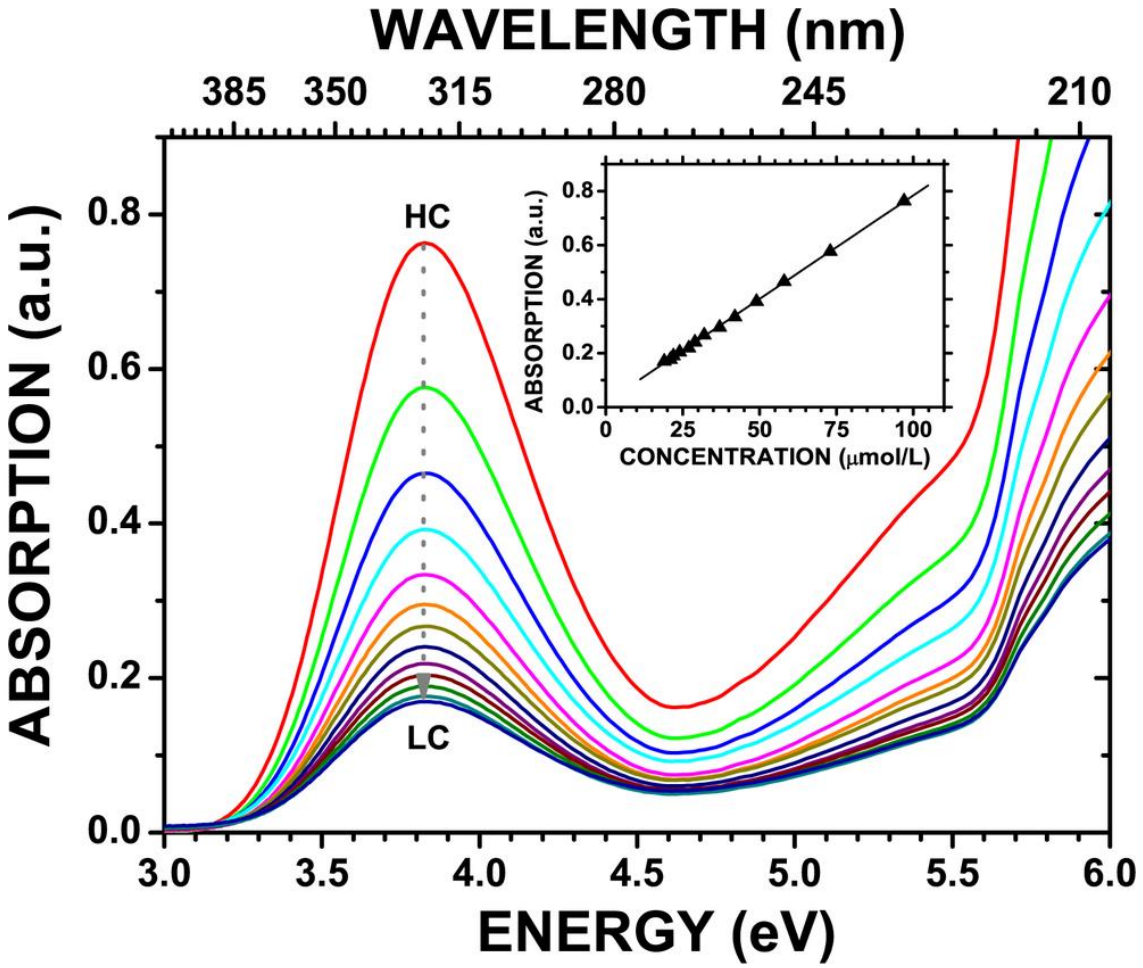
Currently, most forensic laboratories use UV and IR spectrophotometers to characterize chemical compounds.

The simplicity of the UV spectrum facilitates its use as a tool for determining a material's probable identity, although it may not provide a definitive result.

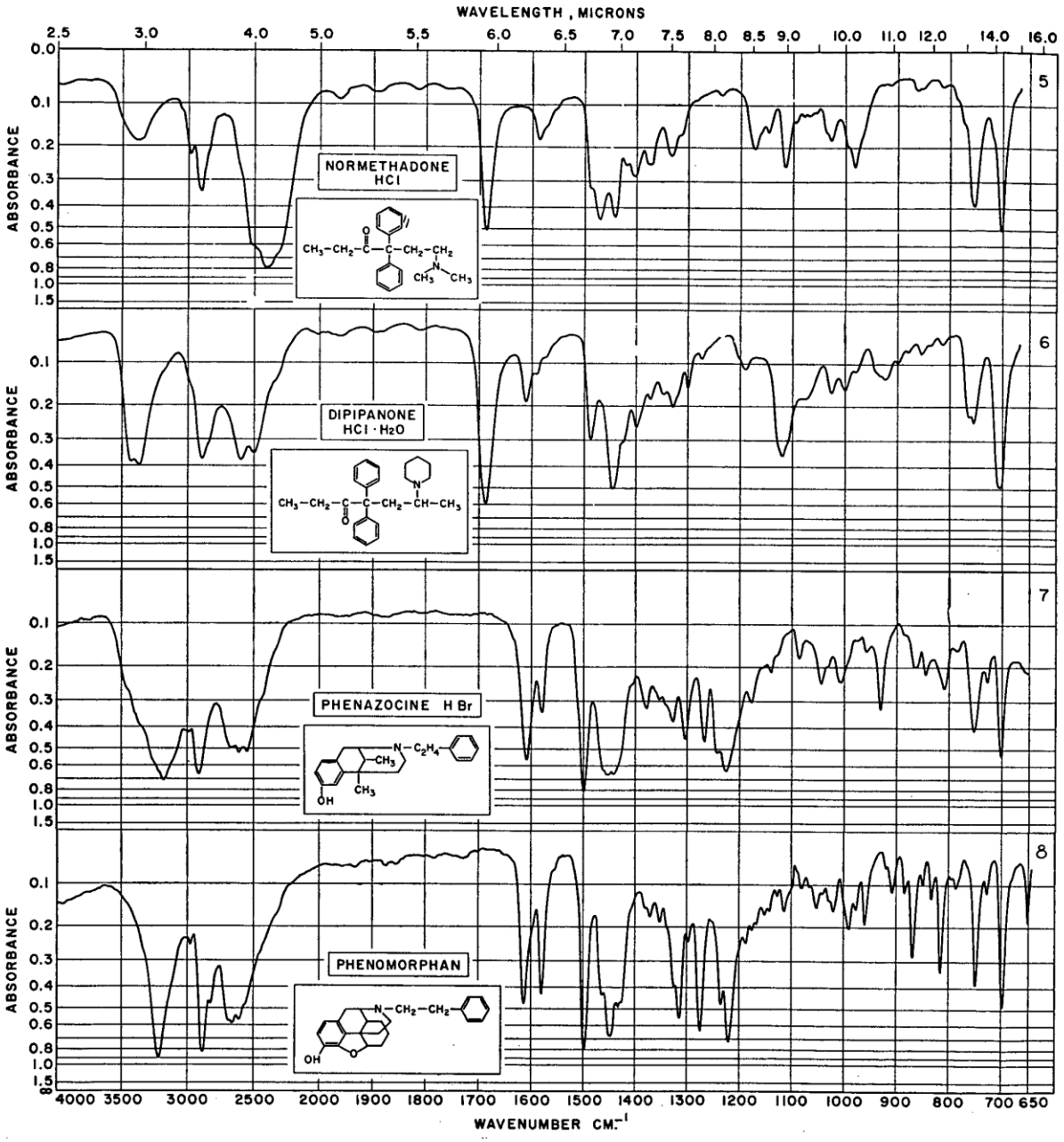
The IR spectrum provides a far more complex pattern.

Different materials always have distinctively different infrared spectra; each IR spectrum is therefore equivalent to an IR "fingerprint" of that substance.

UV Spectra



From:
molecules **2014**, *19*(4), 4145-4156; doi:10.3390/molecules19044145 - See more at: http://www.mdpi.com/1420-3049/19/4/4145/htm#sthash.OZE7WKdB.dpuf



Infrared spectra of narcotics

http://www.unodc.org/unodc/en/data-and-analysis/bulletin/bulletin_1963-01-01_3_page005.html

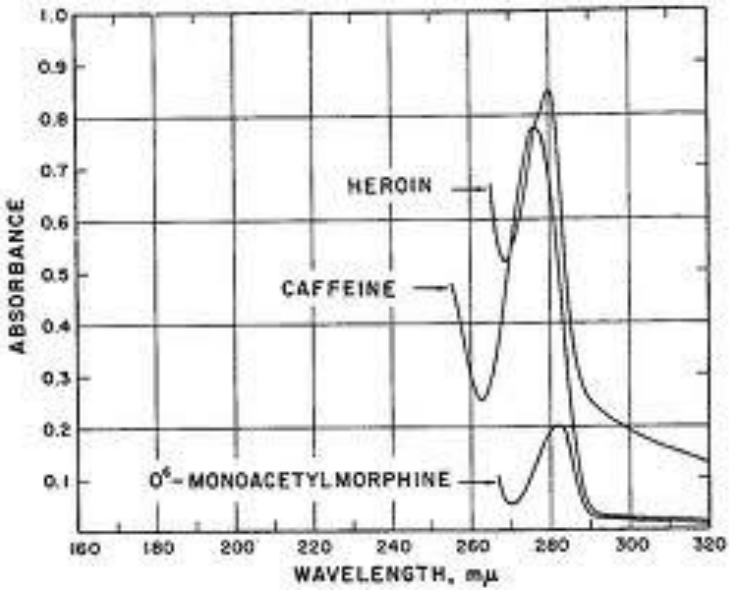
Mass Spectrometry

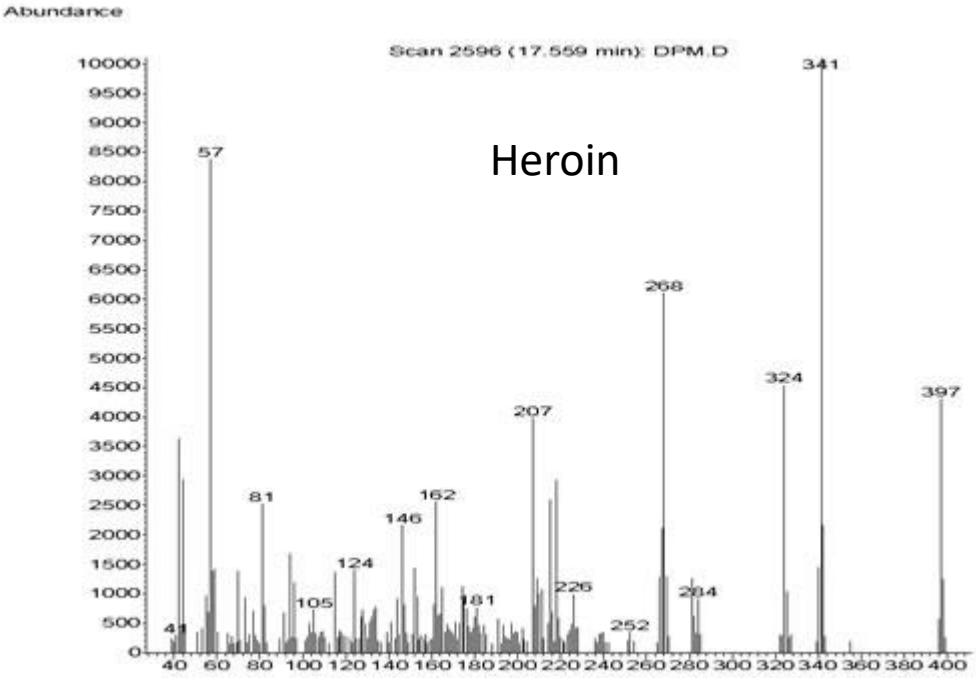
In the mass spectrometer, a beam of high-energy electrons collide with a material, producing positively charged ions.

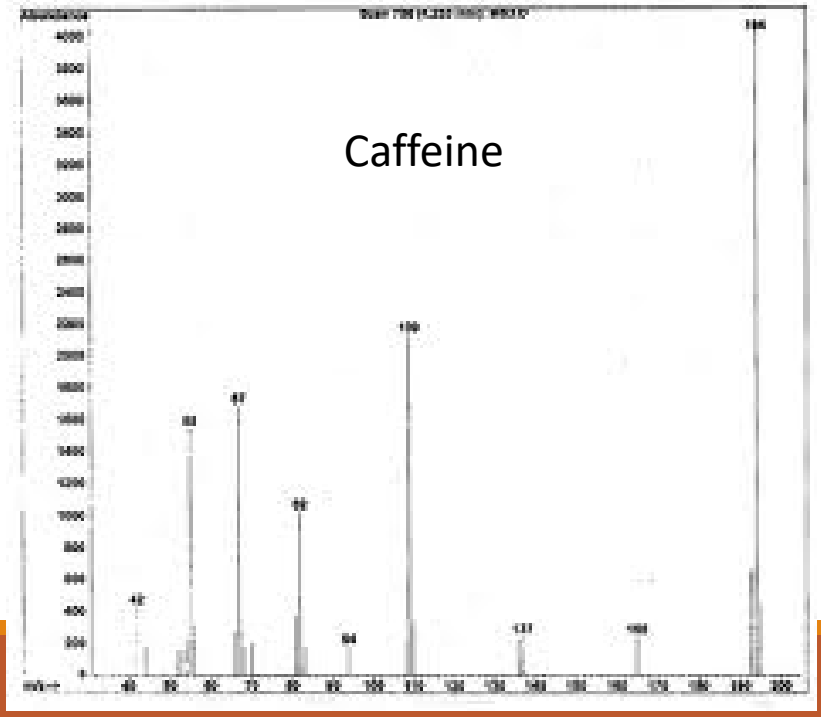
These positive ions almost instantaneously decompose into numerous fragments, which are separated according to their masses.

The unique feature of mass spectrometry is that under carefully controlled conditions, no two substances produce the same fragmentation pattern.

UV vs. Mass Spectra







Spectra from:
http://www.justice.gov/dea/programs/forensicsci/microgram/journal071203/mj071203_pg4.html

GC and Mass Spectrometry

A direct connection between the GC column and the mass spectrometer allows each component to flow into the mass spectrometer as it emerges from the GC.

The separation of a mixture's components is first accomplished by the GC.

Then, fragmentation of each component by high-energy electrons in the mass spectrometer, will produce a distinct pattern, somewhat like a "fingerprint", of the substance being examined.

http://www.trentu.ca/academic/aminss/envmodel/instruments.html

Review

Canadian drug laws overview

Drug offense penalties - old

Introduction to crime scene collection of drugs

Drug identification

- Preliminary analysis,
- Chromatography,
- Spectrophotometry