Introduction to Forensic Science – (Criminalistics)

Basic

Crime **S**cene **I**nvestigation Techniques

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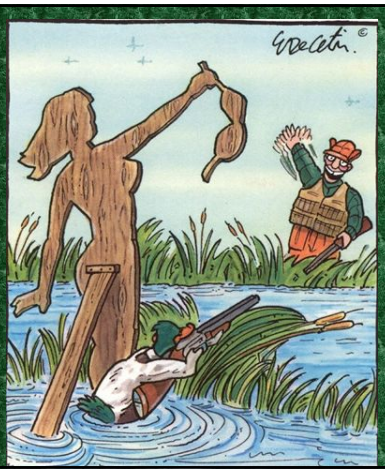

This week the student will learn:

- About physical properties.
- About Glass
- Soil Collection
- Organic Analysis
- Light
- Assorted non-related, superfluous excrement
- There will be a quiz, (primarily on terminology)
- We will look at some "**toys**" later.
- HOMEWORK
  - Read chapters 7 & 8

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Review – Physical Properties

- The forensic scientist MUST constantly strive to determine those properties that impart distinguishing characteristics to matter, giving it a unique identity. (Individual characteristics)
- Individual Characteristics –
  - Properties of evidence that can be attributed to a common source with an extremely high degree of certainty.

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Review – Physical Properties

- Physical Properties
  - Describe a substance without reference to any other substance. (weight, volume, color, boiling point, melting point…)
- Chemical Property
  - Describes the behavior of a substance when it reacts or combines with another substance. (When wood burns it chemically combines with oxygen to form a new substance.

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Review – Physical Properties

- Standards
  - If the property can be assigned a numerical value, it must be one that relates to a standard system of measurement accepted throughout the scientific community.
- Examples:
  - 6.6770 slugs
  - window glass, 5.5 (Moh's scale)
  - Jupiter mean distance to the Sun is 5.2 AU
  - Paper burns @ 457
  - Gravity = 32.2

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Let's Leap In

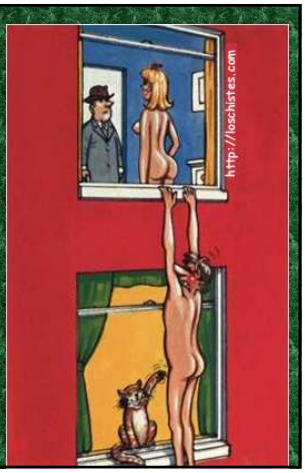
Review – Physical Properties

- Metric System
  - Deci……………… 0.1
  - Centi…….......... 0.01
  - Milli……………. 0.001
  - Micro……...... 0.00001
  - Nano….... 0.00000001
  - Killo……………. 1000
  - Mega…….. 1,000,000
- Metric System
  - Length ----- meter
  - Mass ------- gram
  - Volume ---- Liter
- In this system, volume can also be defined by length.
  - Liter = A cube with 10cm sides or 1000 cubic centimeters.

Review – Physical Properties

- Weight / Mass
  - Gravity's attraction is called weight.
  - The amount of matter in an object is called mass.
  - Gravity changes with location, mass does not change.
  - W=mg
- Basic unit is called a gram (also slug).
  - Take your weight (grams)
  - Divide by the force of gravity. (32.2)
  - Result is your mass (grams).
  - 215lbs=3029grams
  - http://www.convert-me.com/en/convert/weight

It's all in the details.



Review – Physical Properties

- Density
  - Density is Mass per Unit Volume
  - Density=M/V
  - Density is an "Intensive Property" – it is the same regardless of size
- Control of temperature is vital.
- Weigh the solid
- Determine it's volume by water displacement
  - The difference in V_2-V_1 (in milliliters) is equal to the volume.
- Now calculate to get density in grams per milliliter.

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Review – Physical Properties

- Refractive Index
  - The bending of a light wave because of a change in velocity is called refraction.
  - Speed of light in vacuum = 299,792,458 m/s or 186,282.397 mps or 1 foot per nanosecond.
- Refractive Index= speed of light in vacuum / speed of light in medium
- Like density, RI is an "intensive property" – the same regardless of size.
- Control of temperature & light is vital.

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Review – Physical Properties

- Crystalline solids
  - Have definite geometric forms due to the orderly arrangement of atoms.
- Amorphous solids
  - Have atoms arranged randomly throughout.
  - Glass is one example.
- Double refraction
  - Refract light into two different light-ray components
- Birefringence
  - The difference in the two indices of refraction
- Dispersion
  - Separation of light into it's component wavelengths.

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Review – Physical Properties

- Tempered Glass
  - Strengthened by rapid heating and cooling
  - Shatters on impact producing "dice"
  - Creates dicing injuries
  - Creates small, low mass projectiles with little energy
- Laminated Glass
  - Two sheets of glass with a layer of saran-wrap between them for strength
  - Maintains cohesiveness on rupture
  - Can cause major injuries.

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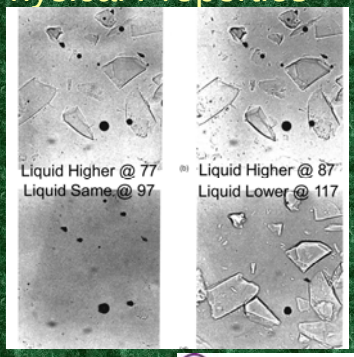
Review – Physical Properties

- Becke Lines
  - Halo near the border of a particle immersed in a liquid of different refractive index.



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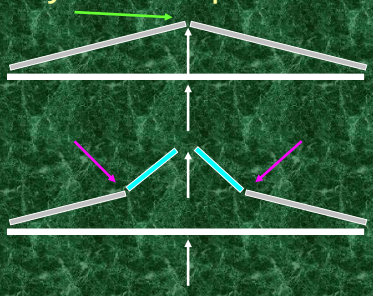
Review – Physical Properties

- Glass BENDS in response to forces applied.
- Radial Lines (spokes) 1st.
- Concentric Cracks (circular) 2nd.



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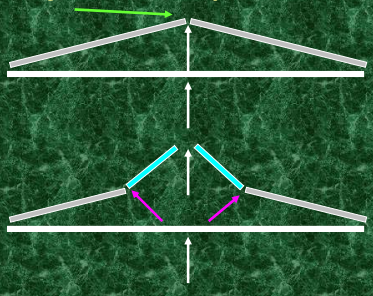
Review – Physical Properties

- Radial Lines begin opposite side of force.
- Concentric Cracks begin same side as force.



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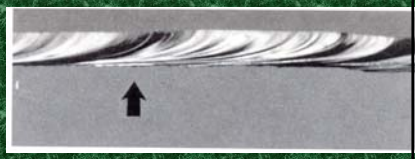
Review – Physical Properties

- Radial Lines the perpendicular end is always located opposite the side of applied force.

Radial Glass Fracture



3 R rule – Radial cracks form a Right angle on the Reverse side of the force.

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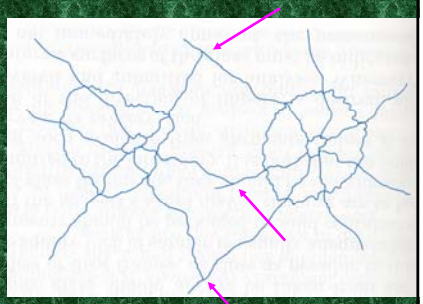
Review – Physical Properties

- A fracture ALWAYS terminates at an existing line of fracture.



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Review – Collecting Soil

- Standards should be collected @ intervals within a 100-yard radius of the crime
- Only the top layer of soil is picked up
- Approx 1-2 Tbls of soil is needed.
- Pack each in a vial
- Vials need to be marked with exact location of sample.
- Soil adhering to an object requires the object taken intact & wrapped in paper.
- Insure no soil can escape the paper.

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Review – Collecting Soil

- In traffic incidents, collect samples from the suspect vehicle off the roadway in clumps if possible.
- When inspecting the suspected vehicle, take samples from under each fender and frame area.
- Collect samples off vehicle in complete clumps.
- The buildup of different soils & their order may produce an individual characteristic.

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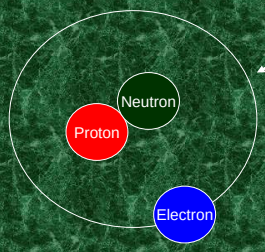
Review – Organic Analysis



Hydrogen Atom

Known as an Element (the fundamental building block of all substances)

109 Elements identified so-far, 89 occur naturally on earth.

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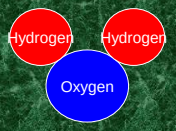
Review – Organic Analysis



Water Molecule

Known as a compound (a pure substance comprised of two or more elements)

>16 million compounds have been identified

The molecule is the smallest unit of a compound

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Review – Organic Analysis

- Sublimation – A physical change directly from solid to gas.
  - Example – dry ice
- Matter – Anything that has a mass and occupies space.
- Inorganic – A chemical compound not based on carbon.
- Physical state – A condition in the physical being of matter.
  - Solid, Liquid, Gas
- Organic – Substance composed of carbon & hydrogen & often small amounts of other elements.

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Review – Organic Analysis

- Different Phases are said to exist when different substances can be distinguished by a visible boundary.
  - Like oil and water
  - Like vinegar and oil
  - Like me and my son-in-law
- Spectrophotometry – the study of the absorption of light by chemical substances.
  - Requires that a substance be in a pure state.
- Chromatography – a means of separating and identifying components of a mix.

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Review – Organic Analysis

- Chromatography based upon observation that chemical substances have a tendency to partially escape into the surrounding environment when dissolved in a liquid or absorbed on a solid.
- Random motion carries some back to the liquid.
- A point will be reached when the number of molecules leaving the liquid are equal to the number returning.
- This is equilibrium

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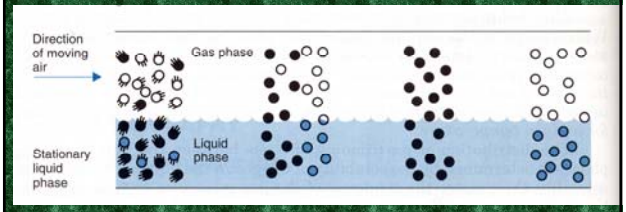
Review – Organic Analysis



General theory behind gas chromatograph

Capable of resolving a highly complex mixture in minutes

Pyrolisis can be used to convert substance to gaseous state first

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Review – Organic Analysis

- HPLC – High Performance Liquid Chromatography
  - Liquid is the moving phase
  - Solid particles are chemically treated and act as stationary phase.
  - Room temperature
- Explosives usually analyzed this way due to heat sensitivity.
- Heat sensitive drugs (like LSD) also analyzed this way.

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Review – Organic Analysis

- TLC – Thin Layer Chromatography
  - Moving Liquid Phase
  - Stationary Solid Phase
  - Uses thin-layer plate
  - Sample applied directly to test plate next to standard.
  - Plate placed upright in closed container of liquid with sample above liquid.
- The liquid will leech up the plate due to capillary action.
- This will separate the different components.
- Plates are placed under ultraviolet light to cause florescence.
  - (emit visible light when exposed to light of a shorter wavelength)

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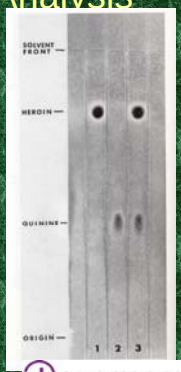
Review – Organic Analysis

- TLC – Thin Layer Chromatography
  - Requires less than 100 micrograms of suspect material for analysis.
- Sample is a test of a material suspected of being Heroin & Quinine



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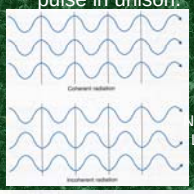
Review – Organic Analysis

- Electrophoresis
  - Related to TLC
  - Instead of a moving liquid, it uses an electrical potential across a stationary medium.
  - Usually used for Proteins like DNA.
- Spectrophotometry
  - Visible light – colored light ranging from red to violet in EM Spectrum.

Review – Organic Analysis

- Spectrophotometry
  - Lowest frequencies are red
  - Highest are violet
  - Normally incoherent (comprised of waves that are out of step)
  - Lasers permit them to pulse in unison.



Review – Organic Analysis

- Spectrophotometry
  - Measures the quantity of radiation that a particular material absorbs as a function of wavelength or frequency.
  - Different materials ALWAYS have distinctively different infrared spectra; therefore each IR spectrum is equivalent to a fingerprint of that substance.

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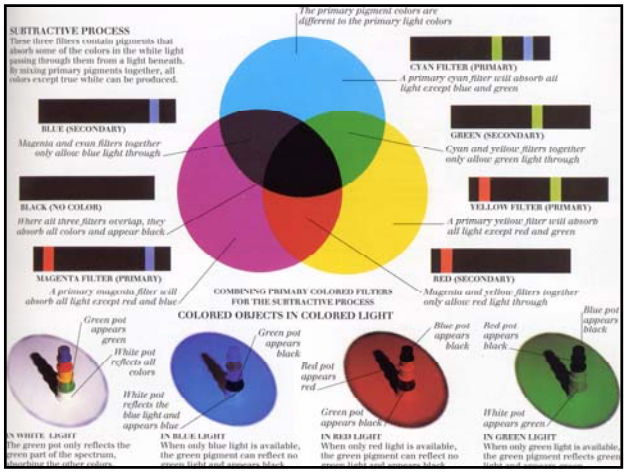
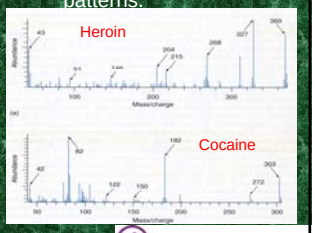


Review – Organic Analysis

- Mass Spectrometry
  - A Gas Chromatograph cannot produce a positive ID.
  - Connection with a Mass Spectrometer overcomes this problem.
  - Known as a GC/MS
  - Sensitive to minute concentrations
  - Mass Spec under proper conditions eliminates all erroneous fragmentation patterns.



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Quiz Week #2

Project #1 – Due week 5

Counts as Mid-term

Obtain 1 old headlight & surgically remove filament.
Examine 4 other light filaments.
Attach all to a card and submit with your observations of each.

Obtain a small broken section of glass and provide a written analysis of the fracture. Submit the glass, OR photographs of the glass.

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Project #2 – Due week 8

Team Project

- Obtain and submit at least 10 latent fingerprints from at least 5 different surfaces.
  One sample must be obtained using your own devices (no kits).
- Classify the fingerprints and provide as complete a description as possible.
- Project #3 will be final. It will be to process a crime scene.

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