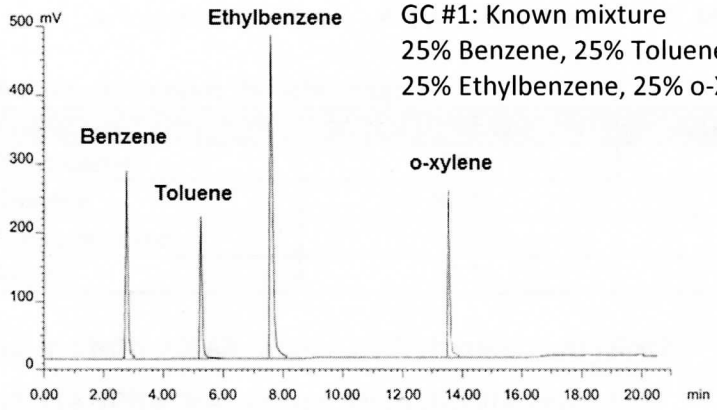
Indiana University Science Olympiad Summer Fun Camp 2011

Forensics A Exam

Judge: Patrick O'Neill

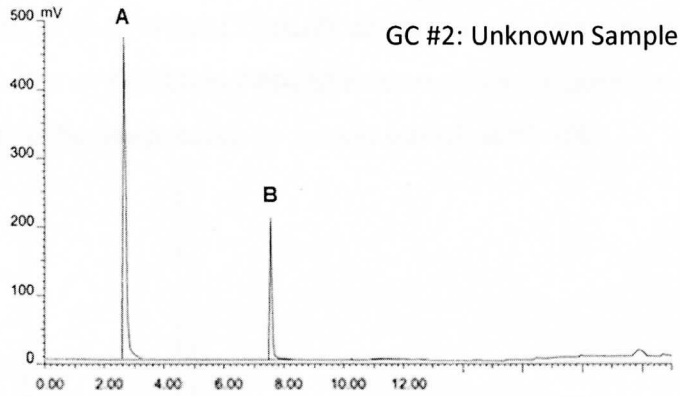
NAMES:

COLOR:



GC #1: Known mixture
25% Benzene, 25% Toluene,
25% Ethylbenzene, 25% o-Xylene

Column: 004-CW 10m x 21mm x 1.0µm
Temperature: 50°C
Detection: FID, 250°C
Injector: 200°C
Carrier Gas: N_2 50.0cm/sec



GC #2: Unknown Sample

1. What is the retention time of o-xylene for this column?
2. What is the inner diameter of the column used in this analysis?
3. What does FID stand for?
4. Which chemical has the greatest signal strength?
5. What chemical does peak A indicate is in the mixture?
6. What chemical does peak B indicate is in the mixture?

For questions 87-92: How would the following changes affect the retention time of the mixture?

A. Increase B. Decrease C. No effect D. Depends upon the chemical

7. Decreasing the length of the column
8. Increasing the film thickness
9. Changing to a different carrier gas
10. Increasing the carrier gas velocity
11. Increasing the temperature of the column
12. Using a more polar column

13. What is the component of a gas chromatogram that most influences the separation of compounds?
A. Injector B. Stationary Phase C. Mobile Phase D. Temperature

A mixture contains the following:

CHEMICAL	MOLECULAR WEIGHT	BOILING POINT	SOLUBILITY IN WATER
Napthalene	128.2	218°C	30mg/L
Toluene	92.1	111°C	470mg/L
Ethylene Glycol	62.0	197°C	Miscible
Phenol	94.1	181°C	8300mg/L

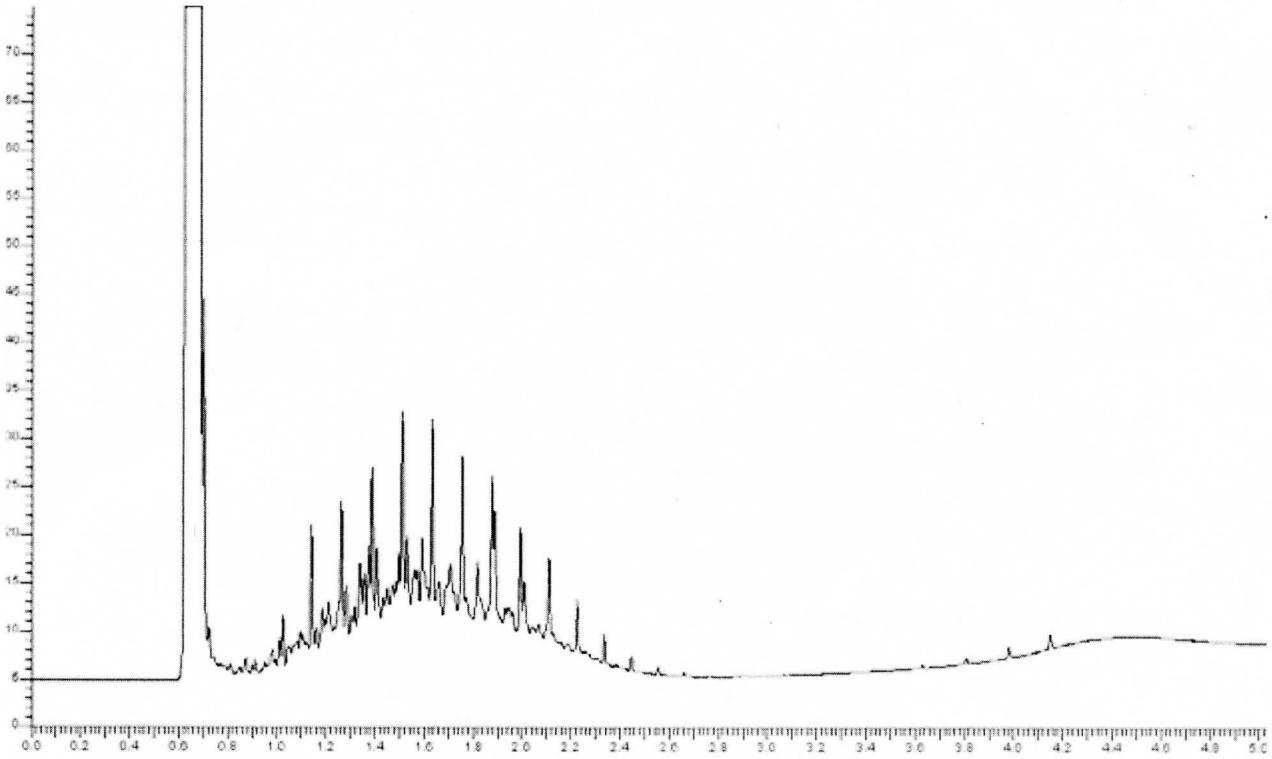
14. In a **NON-POLAR** column which chemical elutes **first**?

15. In a **NON-POLAR** column which chemical elutes **last**?

16. In an **EXTREMELY POLAR** column at low temperature which chemical elutes **first**?

17. In an **EXTREMELY POLAR** column at low temperature which chemical elutes **last**?

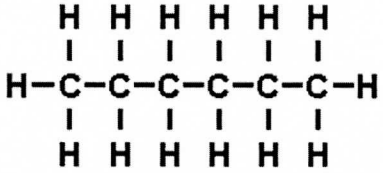
Use the image below to answer questions 98-100:



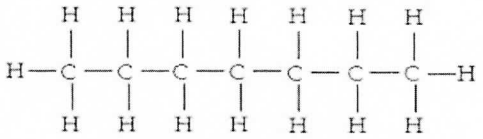
18. What is the incredibly large peak at 0.6 minutes from?

19. Remember that diesel range organics are from C10-C25. This is a diesel standard. What is the approximate diesel range organic window for this column?

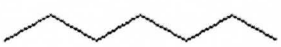
For 20-22 state which has the higher boiling point and explain why.

20. 

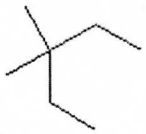
Hexane

vs. 

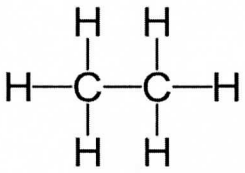
Heptane

21. 

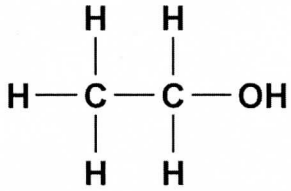
Heptane

vs. 

2-methyl-2-ethylbutane

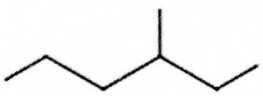
22. 

Ethane

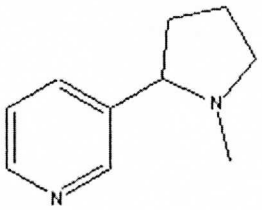
vs. 

Ethanol

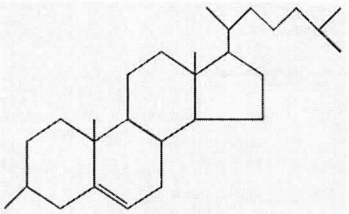
Draw out the full chemical structure (showing every atom and bond) for the following skeletal diagrams:

23. 

3-methylheptane

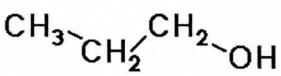
24. 

Nicotine

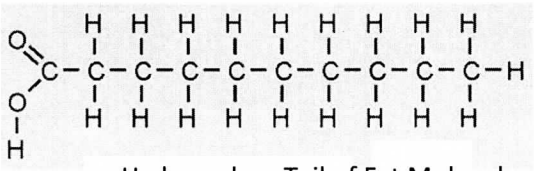
25. 

Cholesterol

Draw the skeletal diagram for the following chemicals:

26. 

Propanol

27. 

Hydrocarbon Tail of Fat Molecule

Determine if the following hydrocarbons are saturated or unsaturated, if unsaturated name the degrees of unsaturation. NOTE: All of these molecules' chemical structures appear earlier on this page.

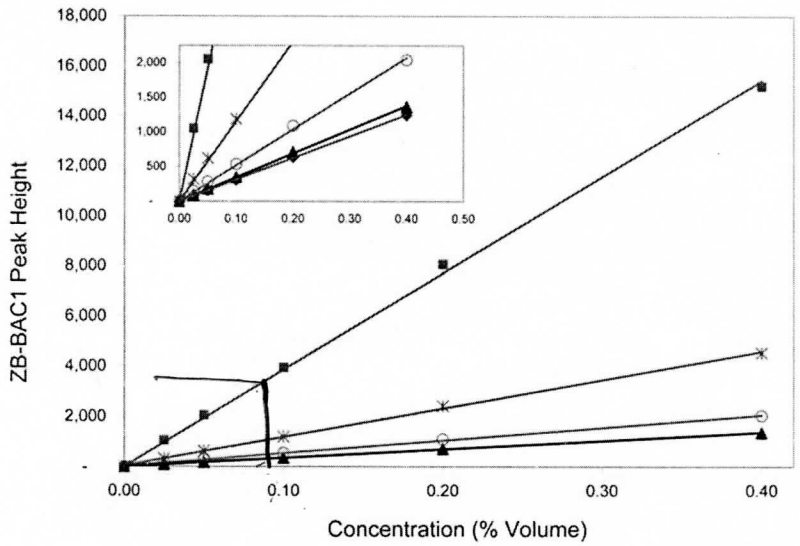
28. Heptane 29. 2-methyl-2-ethylbutane 30. Cholesterol

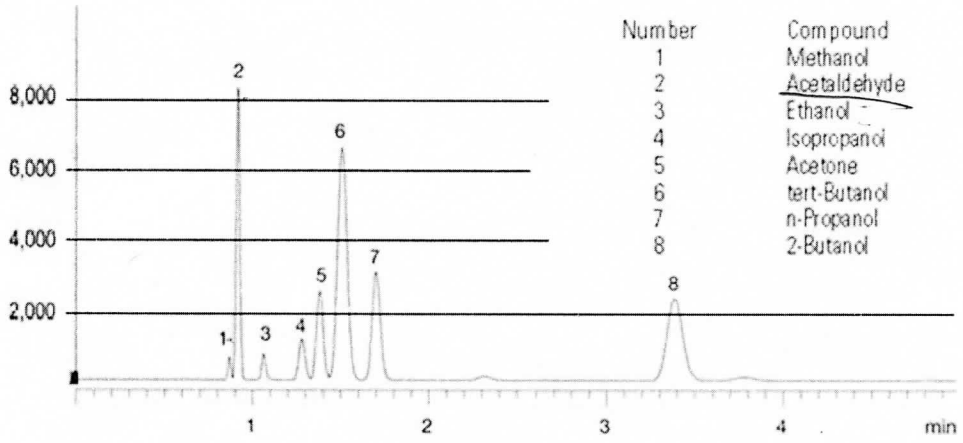
Define the following terms:

31. Volatility 32. Headspace 33. Olefin 34. Arene 35. Crude Oil

36. Would you describe the usage of gas chromatography to measure blood alcohol content to be a qualitative or quantitative analysis? WHY?

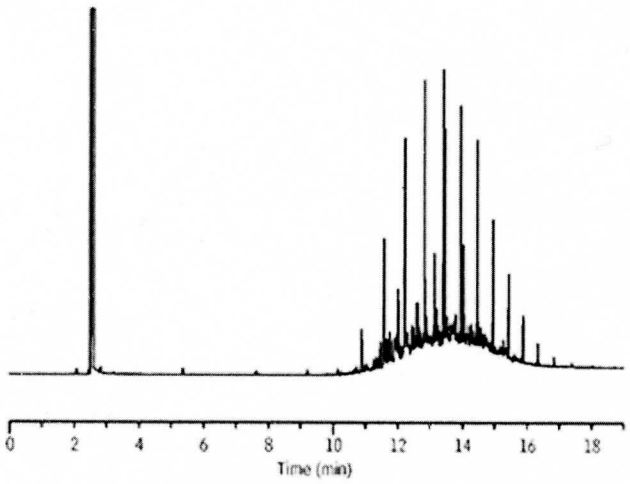
KEY: Methanol (diamond), Ethanol (triangle), isopropanol (circle), acetone (star), and acetaldehyde(square).

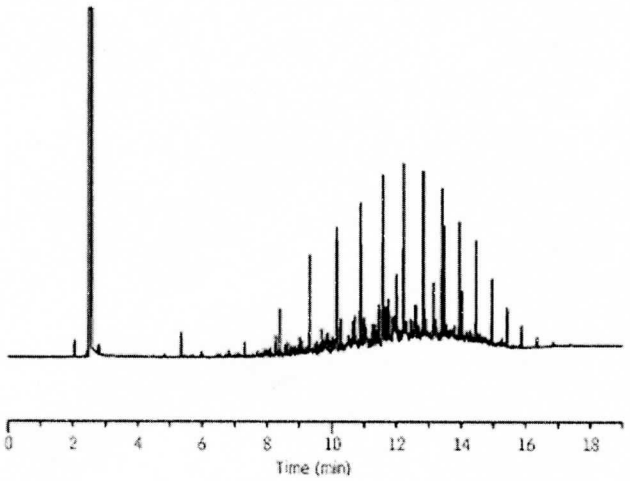




37. The legal limit for blood alcohol content in a driver in Indiana is .08. The above gas chromatogram is from a driver's blood sample who insists he had not been drinking enough to have been over the limit. Does the above gas chromatogram suggest he is guilty of drunk driving? **WHY?**

The following diagrams are from a sample of diesel that is weathered and a sample of diesel that is not weathered.





38. Is the above or below chromatogram the weathered sample? How can you tell?

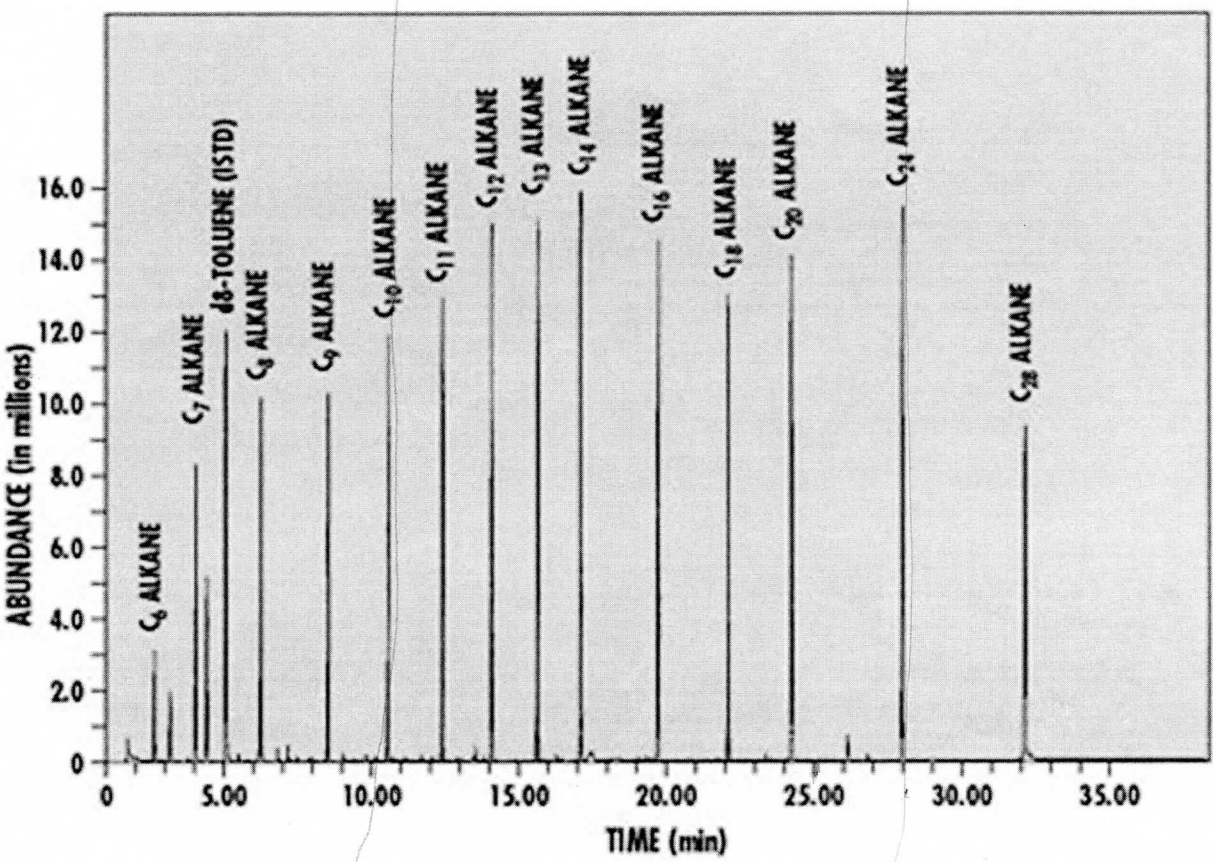
39. Name one material that pyrolysis might be useful to analyze.

40. Put the following in order from smallest molecules to largest molecules:

    Diesel, Lubrication Range Organics, Kerosene, Petrol

For the following hydrocarbons, are they saturated or unsaturated? How many degrees unsaturated?

41. C_4H_{10} 42. $C_{12}H_{20}$ 43. $C_{10}H_{14}$ 44. CH_4 45. $C_{15}C_{32}$



Remember that the diesel range organics are from C10-C24.

46. What is the diesel range organic window for this column?

CRIME SCENE EVIDENCE

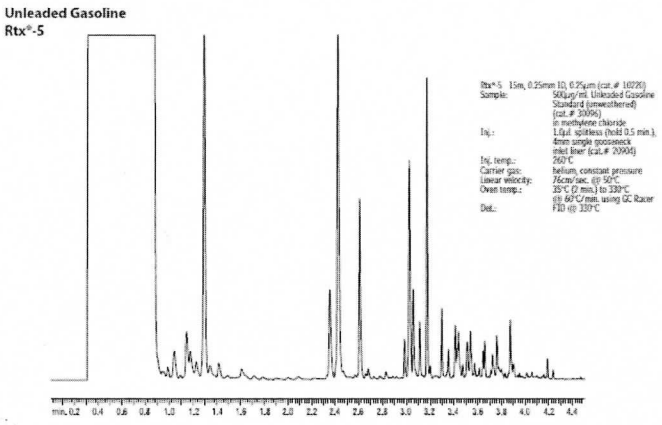
47. A sample from the suspected arson has been recovered. It is a chunk of burned wood. What is the name of the gas chromatography technique that is used to analyze solids/polymers?

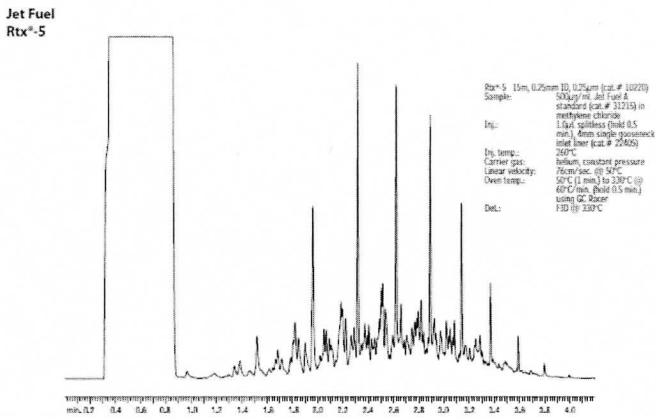
48. What type of container would be appropriate for storing the fire debris?

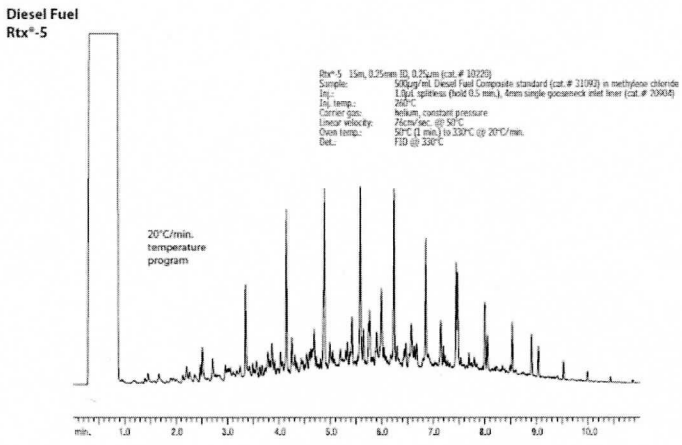
49. Describe how the gases from the sample can get to the GC machine.

50. The following accelerants have been found in some of the suspects' possession. Who is implicated?

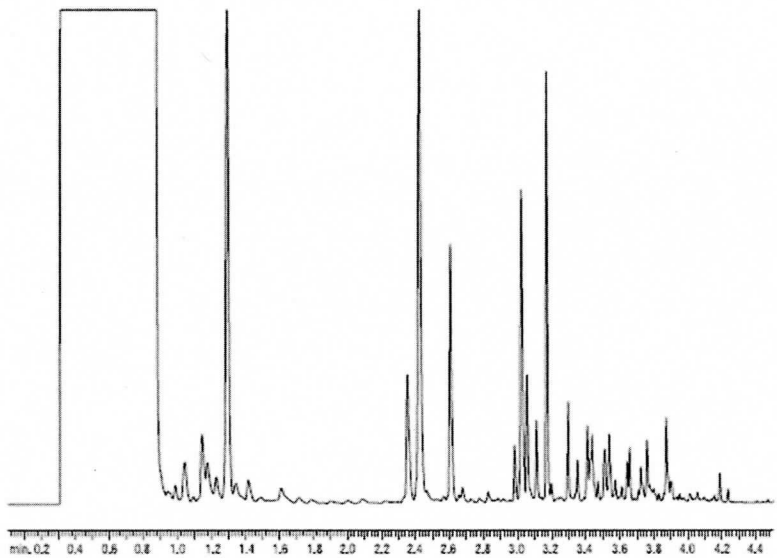
Kirsten – Gasoline Patrick – Diesel Fuel Martin – Jet Fuel







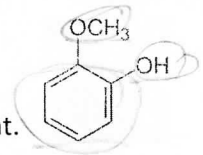
FIRE DEBRIS EVIDENCE



Gas Chromatography is often connected to a machine called a mass spectrometer. Mass spectrometers require pure substances for analysis, so GC is used to separate mixtures into individual components and then single components are fed into the mass spec machine.

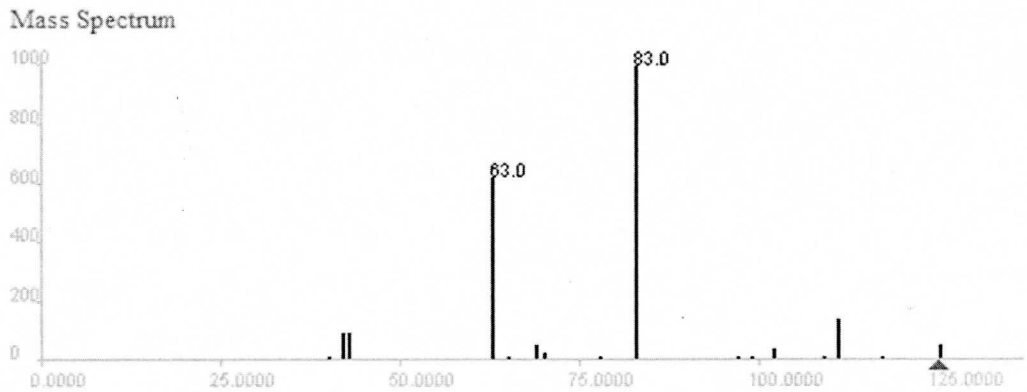
In a mass spectrometer, molecules are broken apart and each signal represents a different fragment of the molecule. The following properties make a molecule less likely to fragment as they stabilize it:

Double Bonds
Cyclic structures
Aromatic Groups (Really Strong!!!)

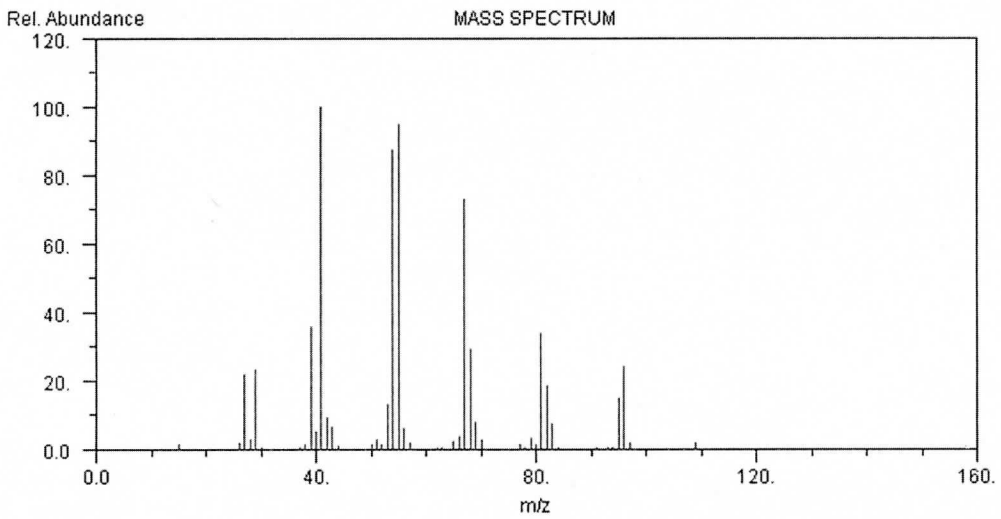


The preservative with the mummy was found to be guaiacol, shown to the right.

MASS SPECTRUM FROM PATRICK'S GROUP



MASS SPECTRUM FROM SLAVEN'S GROUP



51. Which research group has a mass spectrum that appears to correctly match guaiacol? WHY do you think so?