

*Analysis of Gasoline & Fuel System Products:
An Introduction to GLC in General Chemistry*



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Presentation Topics

- **Introduction to Petroleum Extraction & Production**
- **Chromatograms of STP[®] products, street-grade gasoline, and lighter fluid**
- **Questions related to chromatograms...Assessment**
- **Student Survey Results**



Sampling of Automotive Fuel Products Analyzed Qualitatively

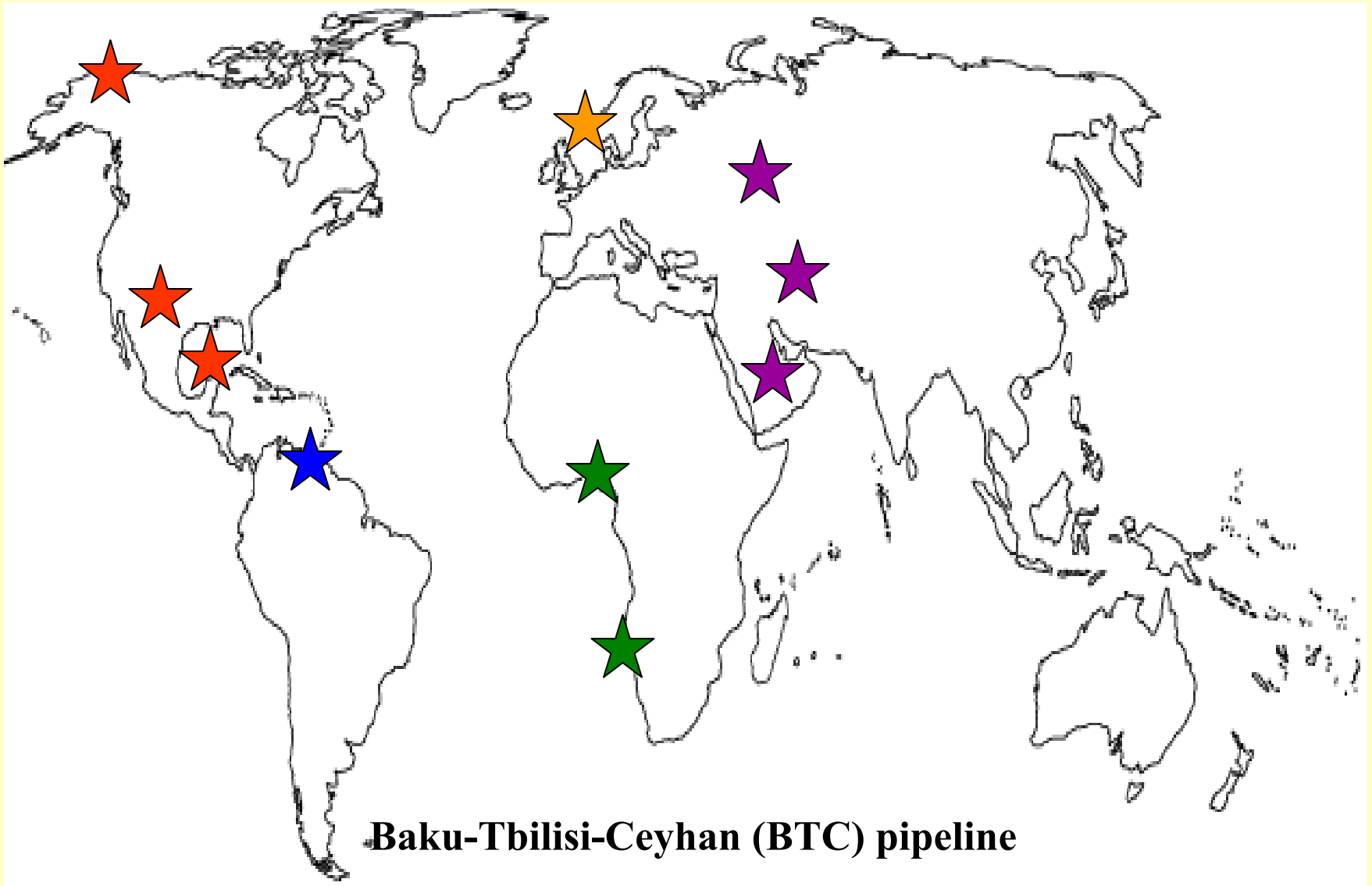
Fuel Injector &
Carburetor Cleaner

Gas Treatment



Contains: *Petroleum Distillates*

Global Crude Oil Extraction



Instrument: Perkin-Elmer Clarus 500

Column: Elite-5, 30m x 0.25mm id x 0.25 μ m

Carrier: UHP Helium, 25cm/s (isobaric)

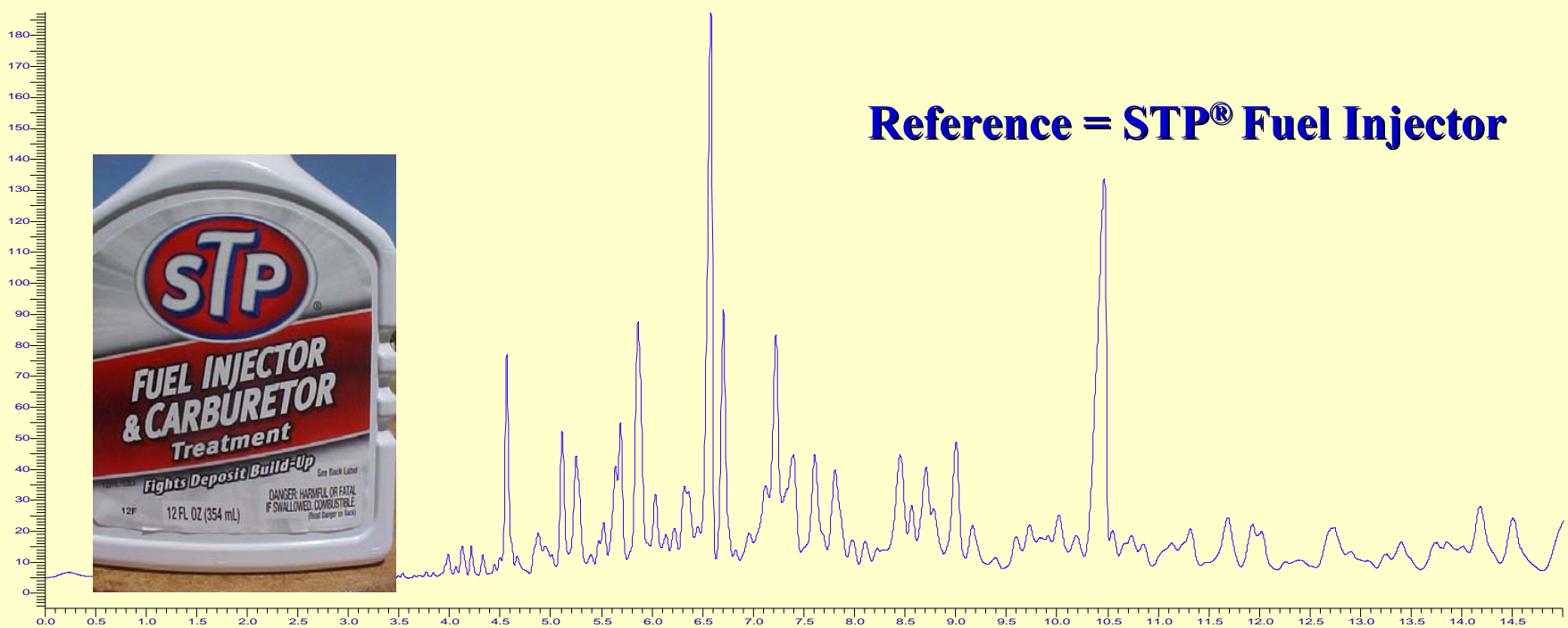
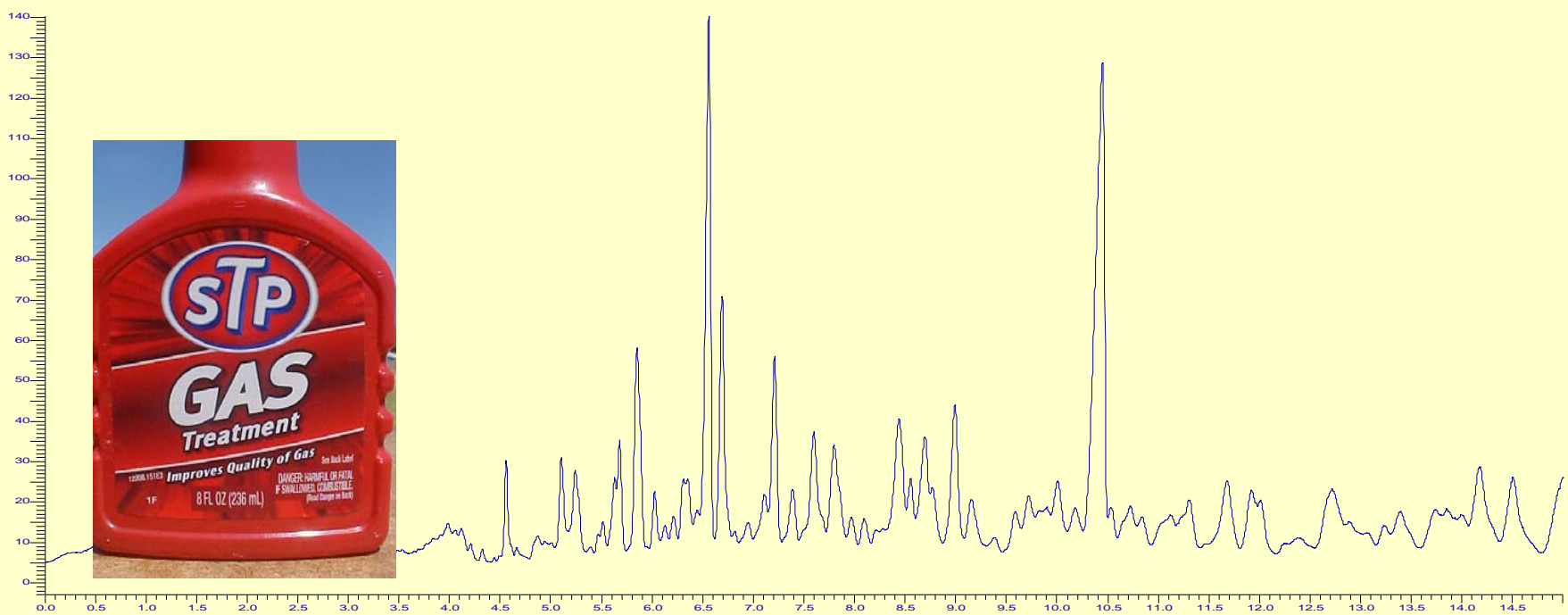
Oven: 100 $^{\circ}$ C (isothermal)

Injector: 150 $^{\circ}$ C; split 50:1, 0.3-0.5 μ L

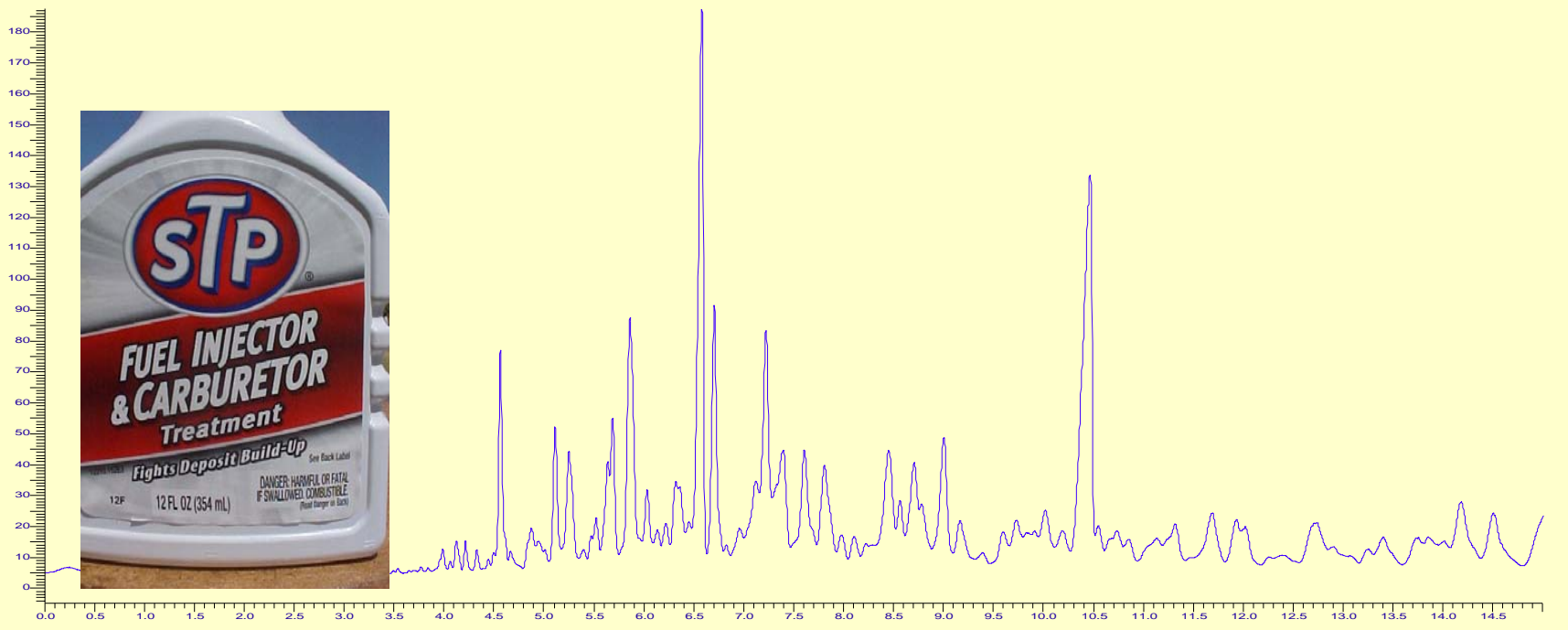
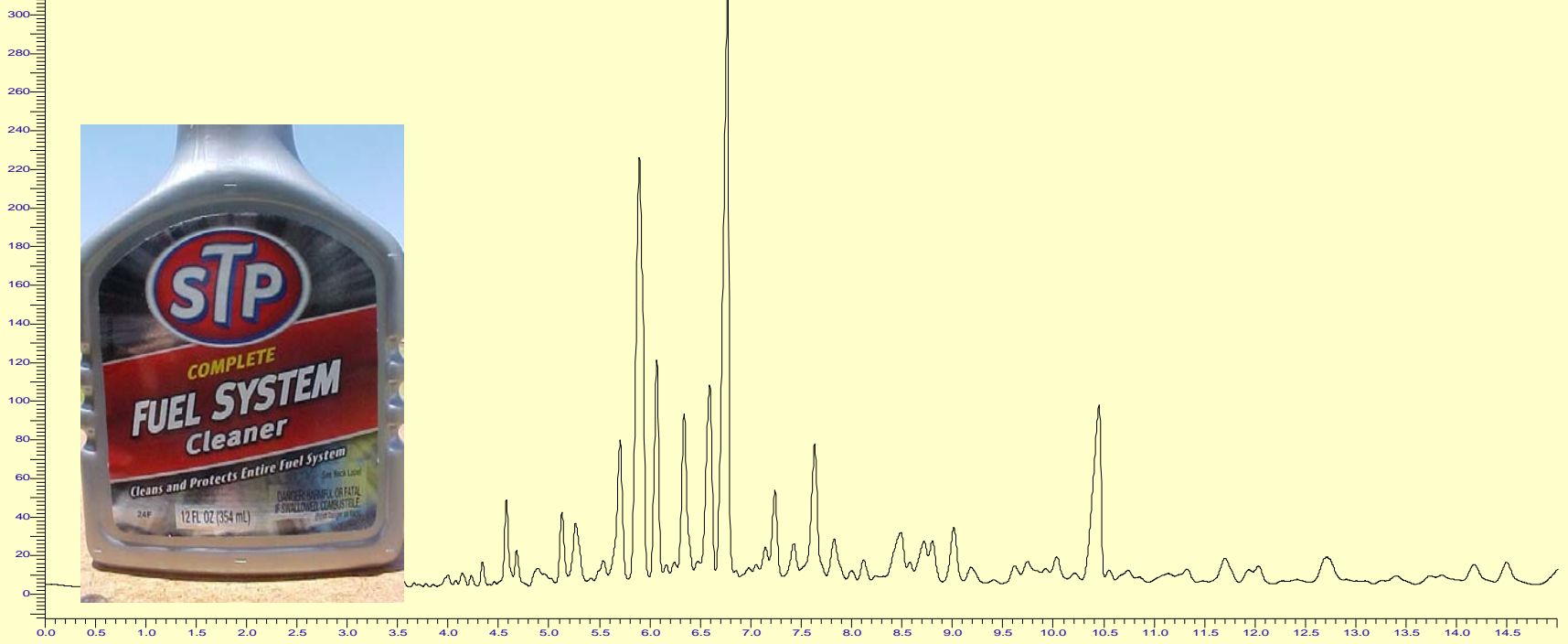
Detector: FID, 175 $^{\circ}$ C

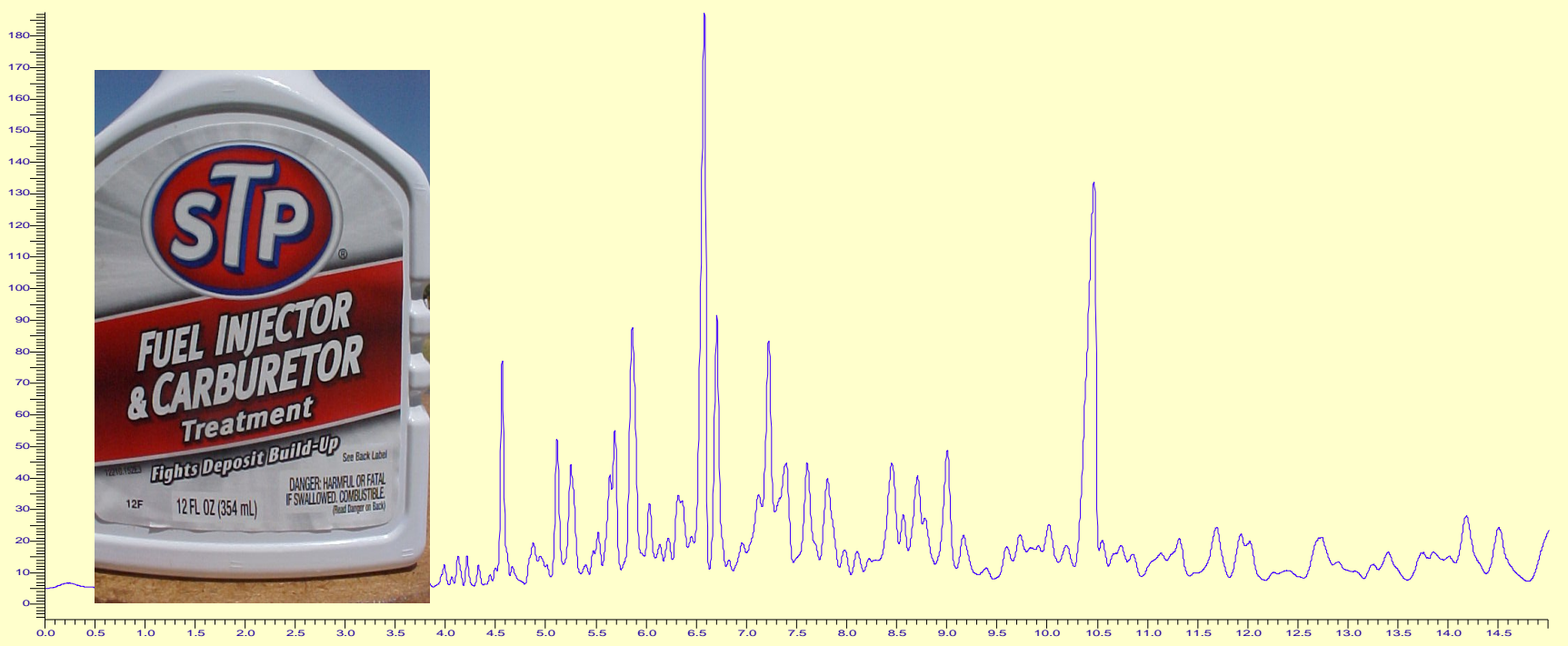
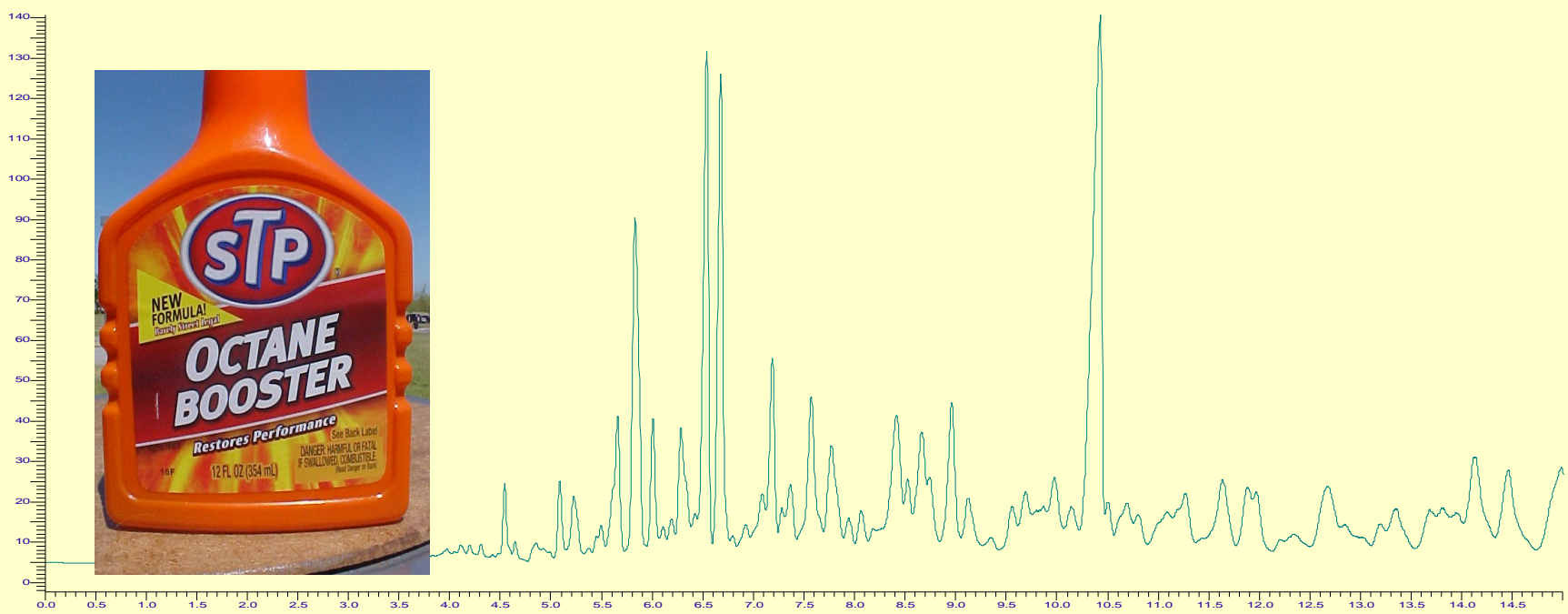
Analysis time: 15 min

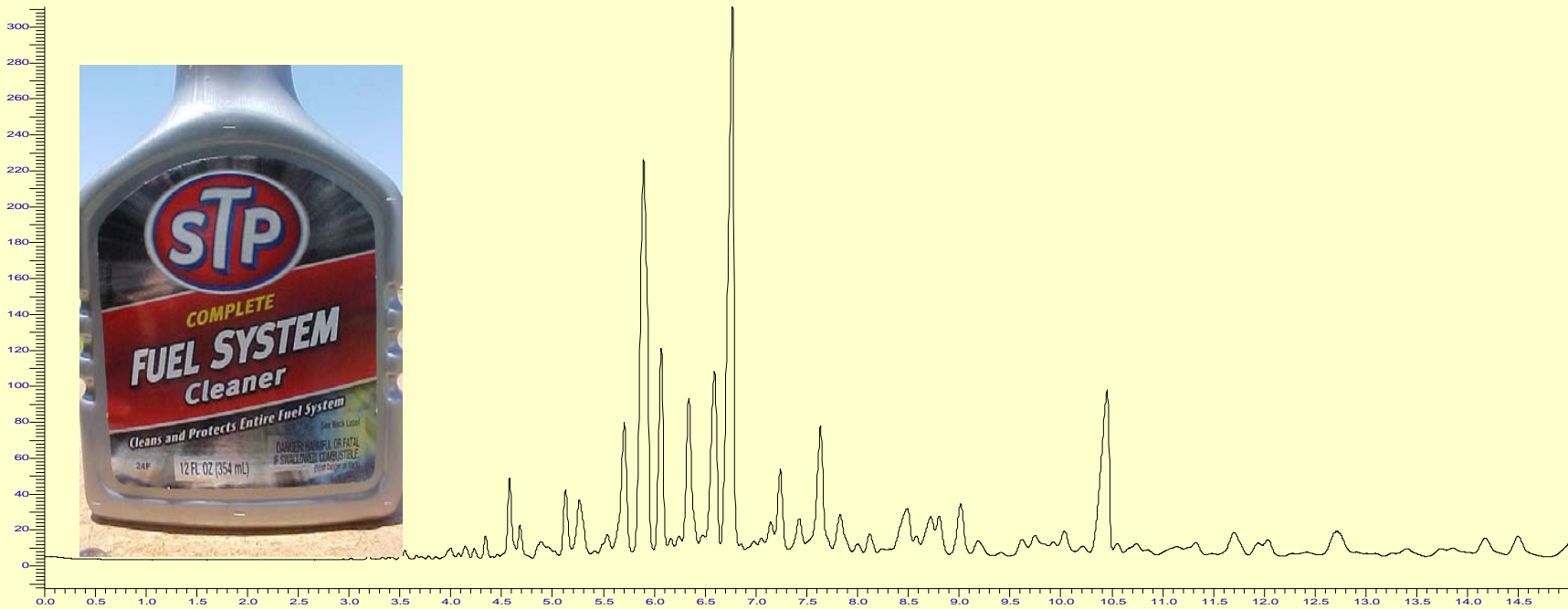


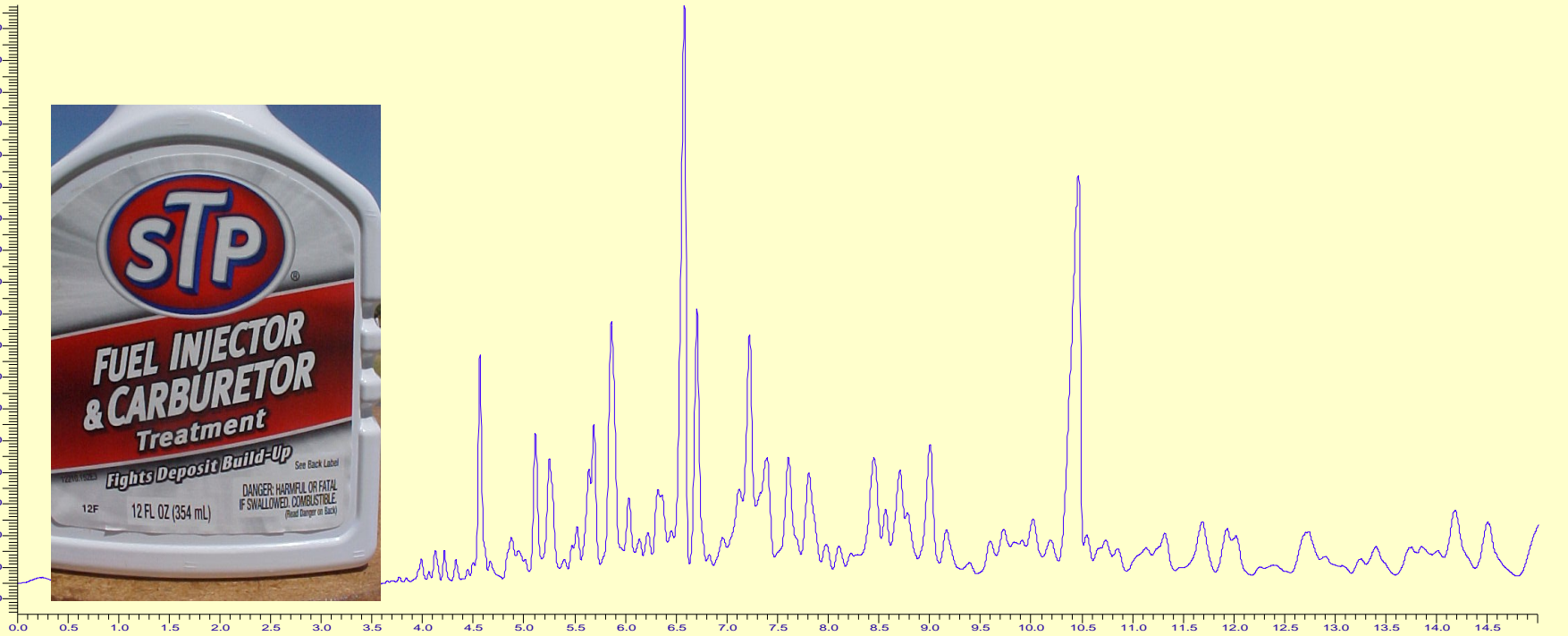
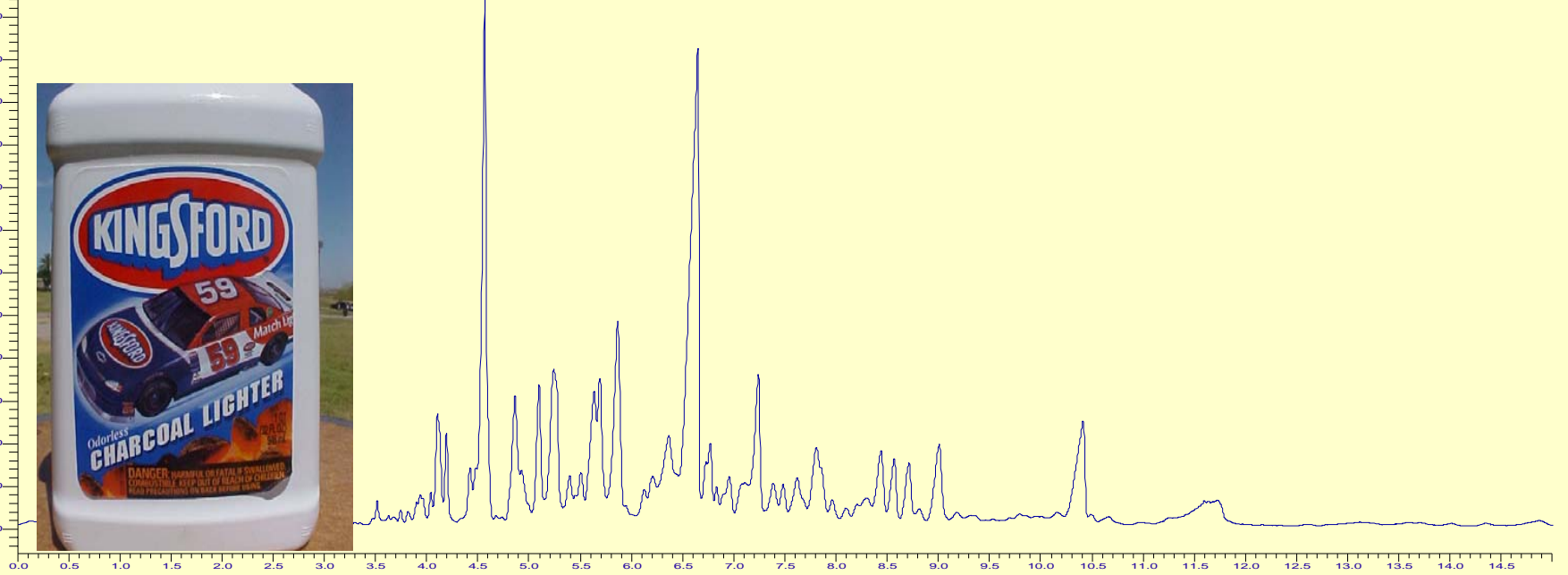


Reference = STP® Fuel Injector

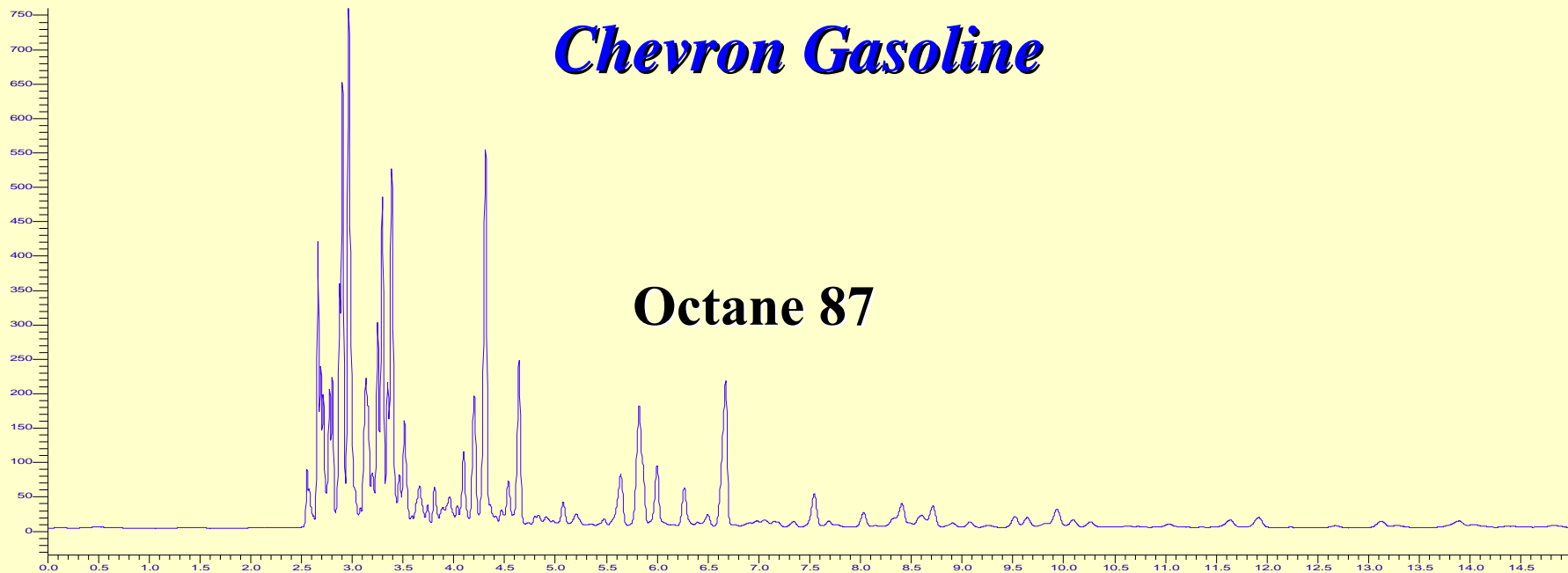




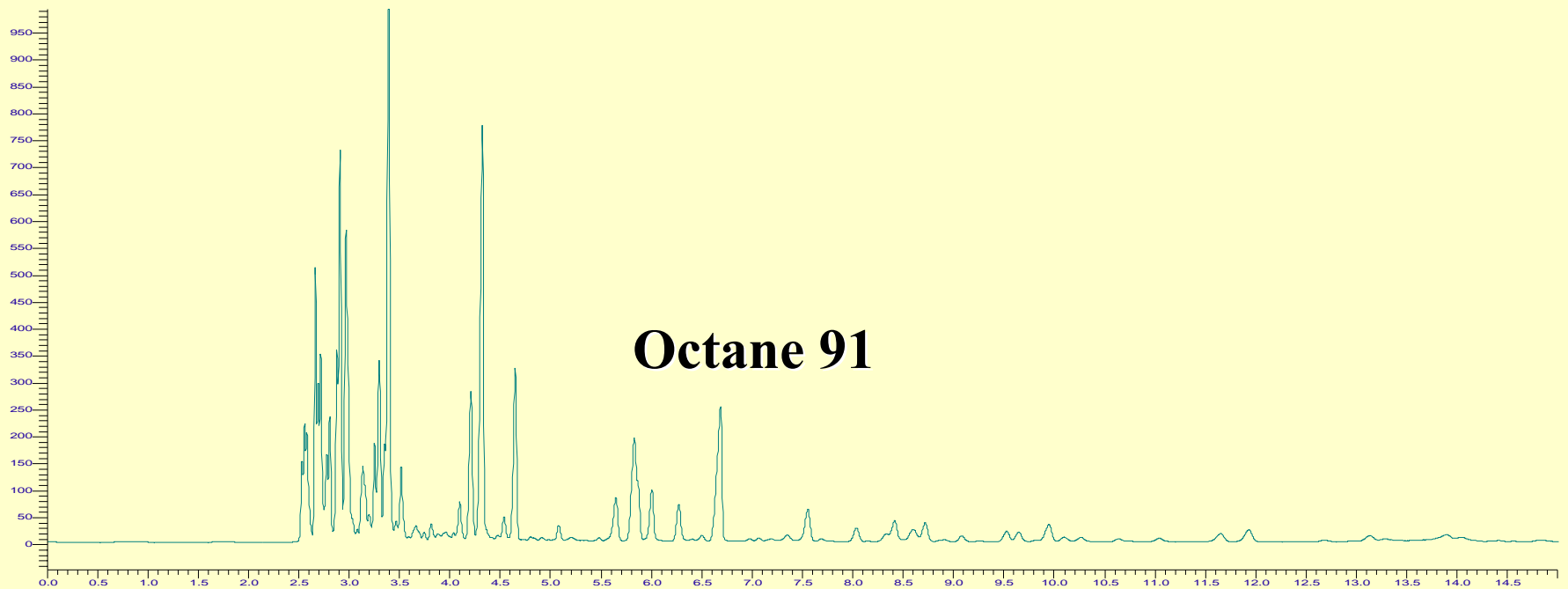




Chevron Gasoline



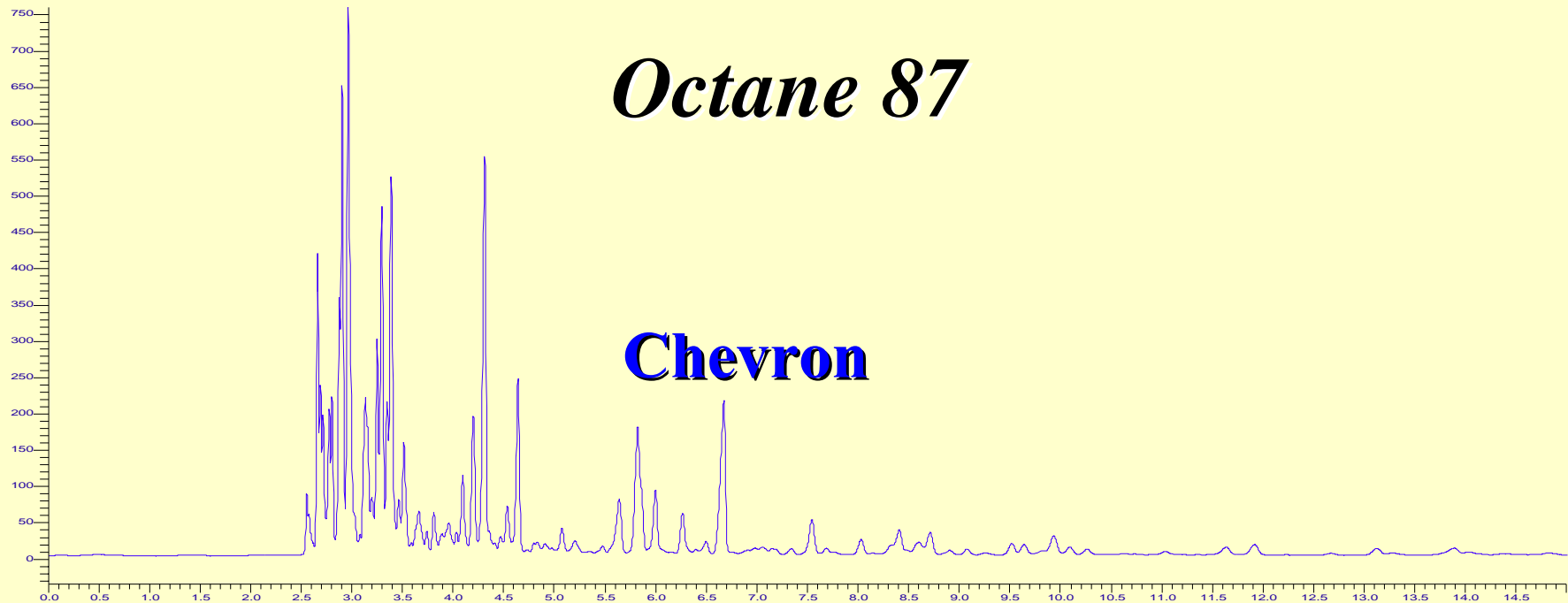
Octane 87



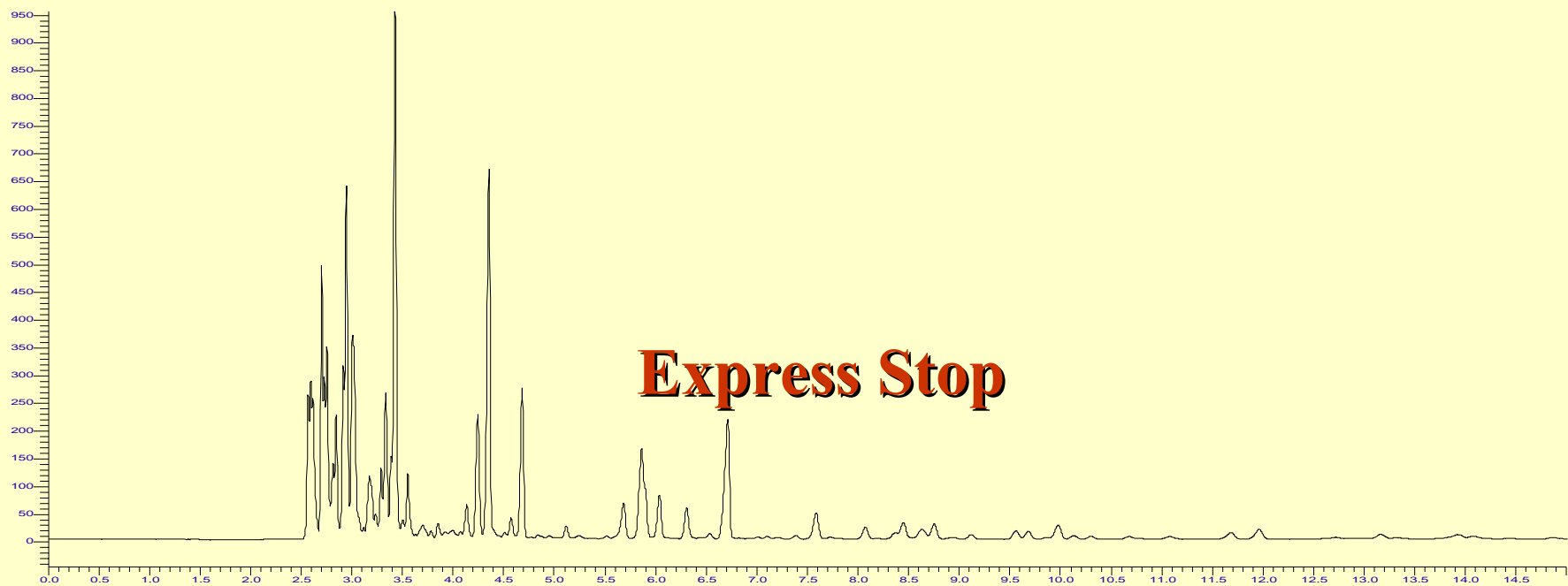
Octane 91

Octane 87

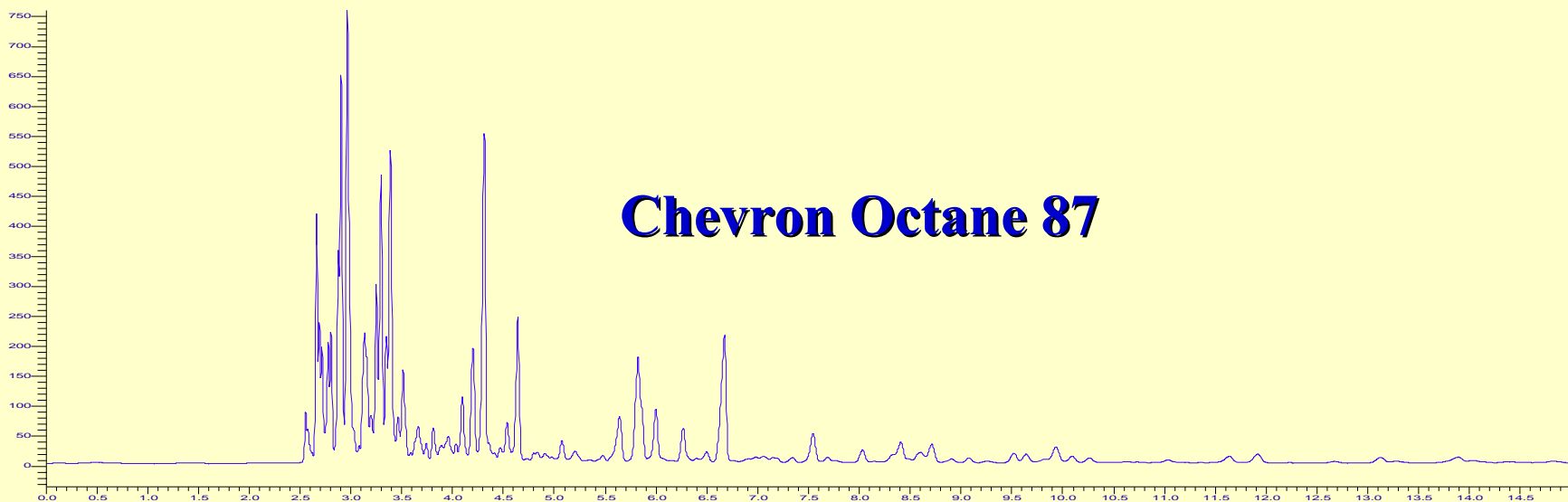
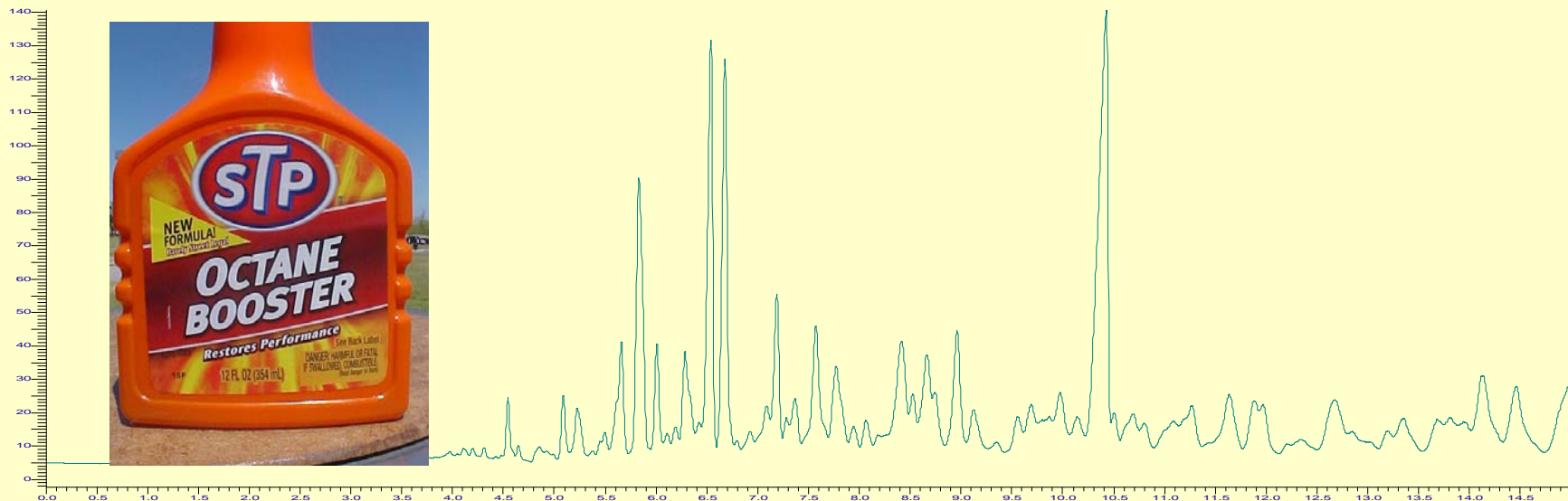
Chevron



Express Stop

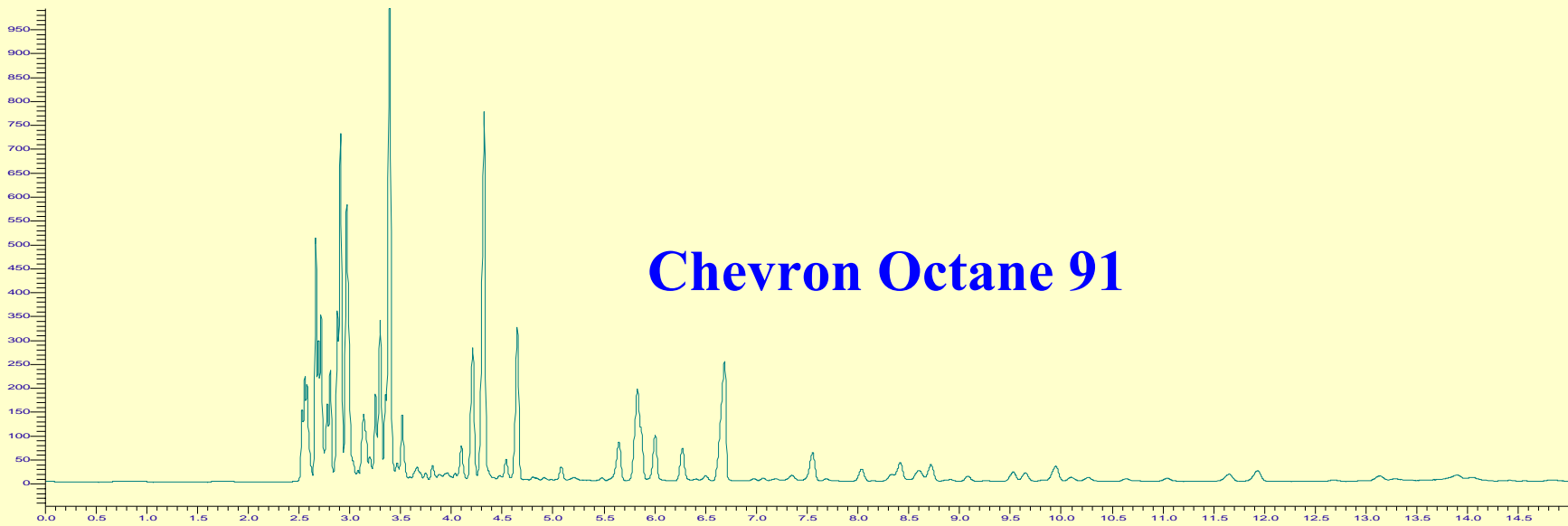
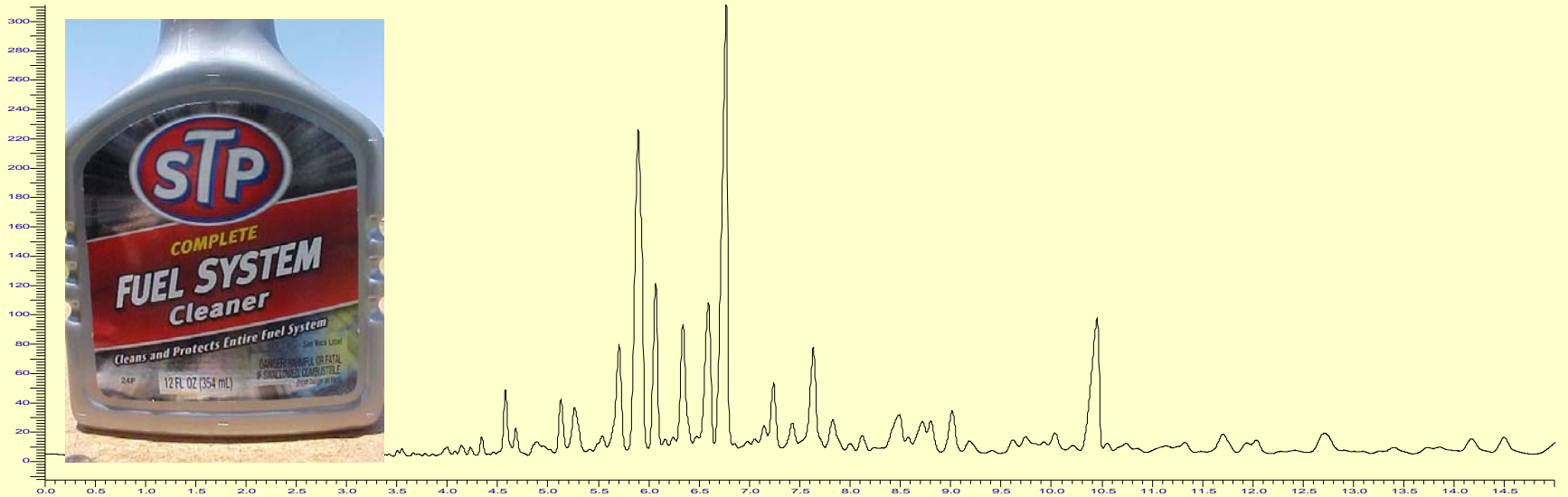


Which product has the greater degree of higher molecular weight compounds? *Give an explanation to support your choice.*

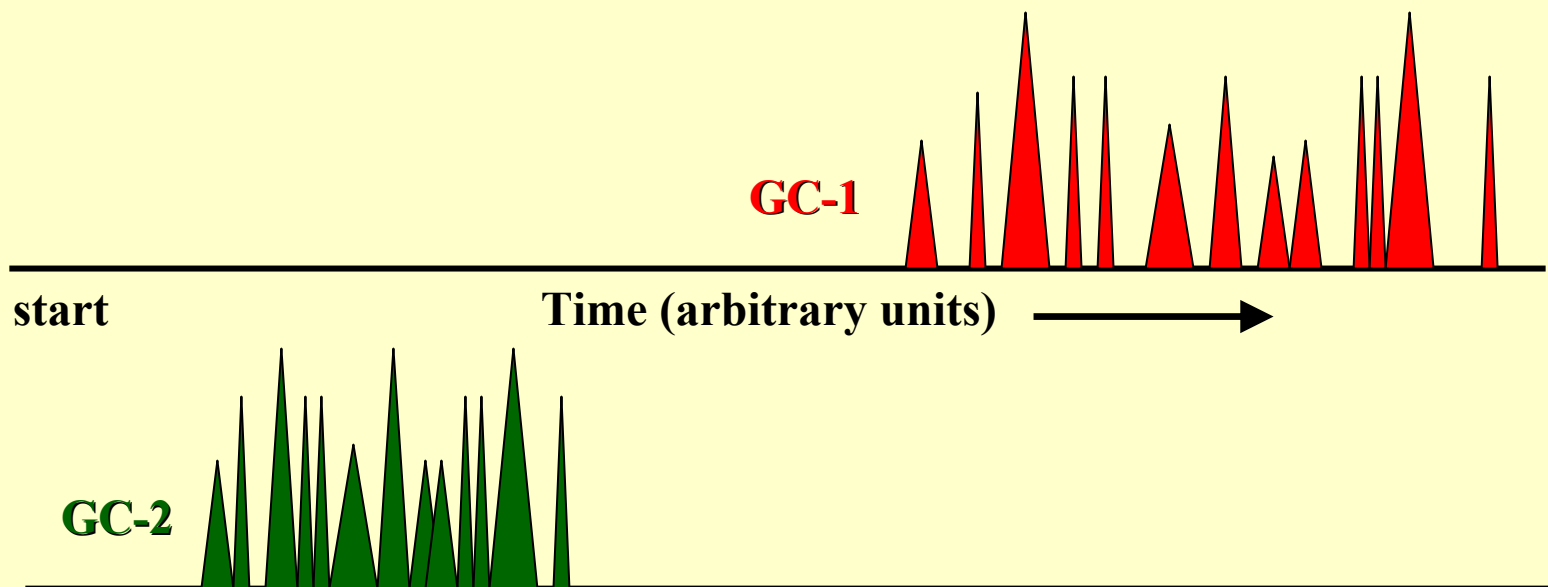


Chevron Octane 87

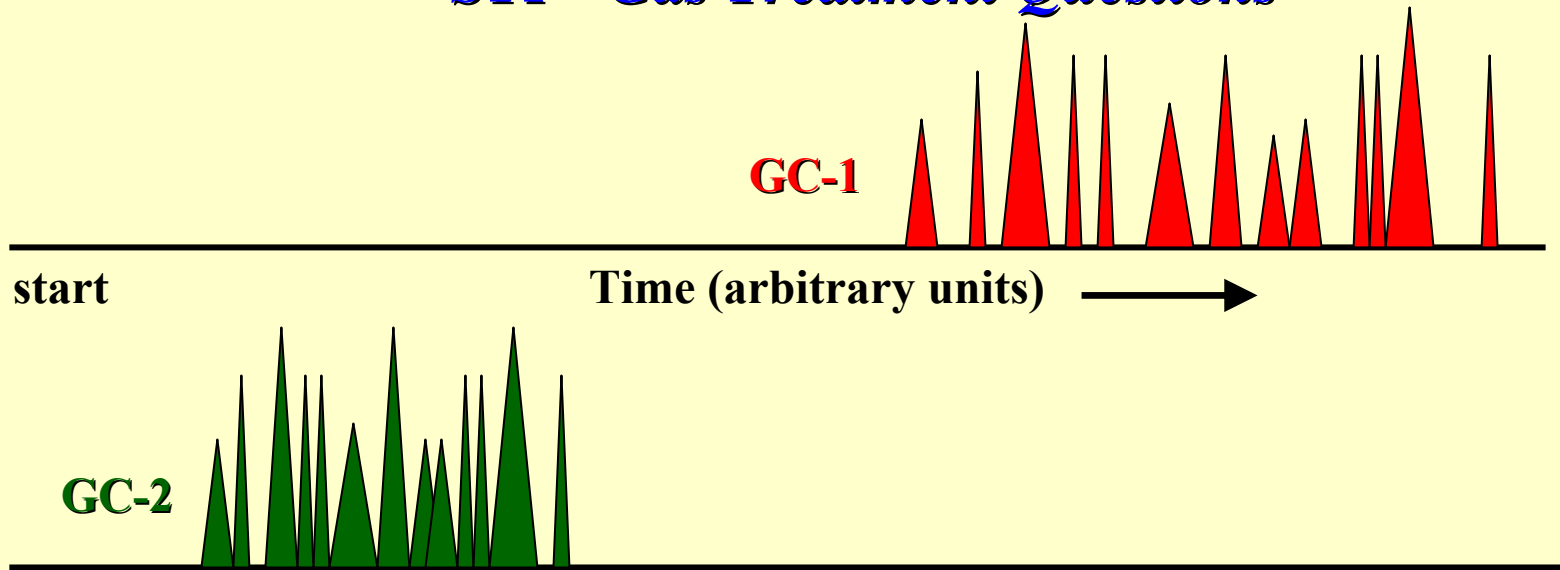
Which product has the greatest degree of higher volatile compounds? *Give an explanation to support your choice.*



Last week separate 0.3 μ L injections of STP[®] Gas Treatment were done on the two GCs located in different rooms. Their approximate chromatograms are shown below. The STP[®] Gas Treatment label reads *Contains Petroleum Distillates*, which are basically medium molecular weight (MW 80-100), intermediate boiling (bp range 100-130^oC) saturated hydrocarbons. Answer questions A.-C. on the next page.

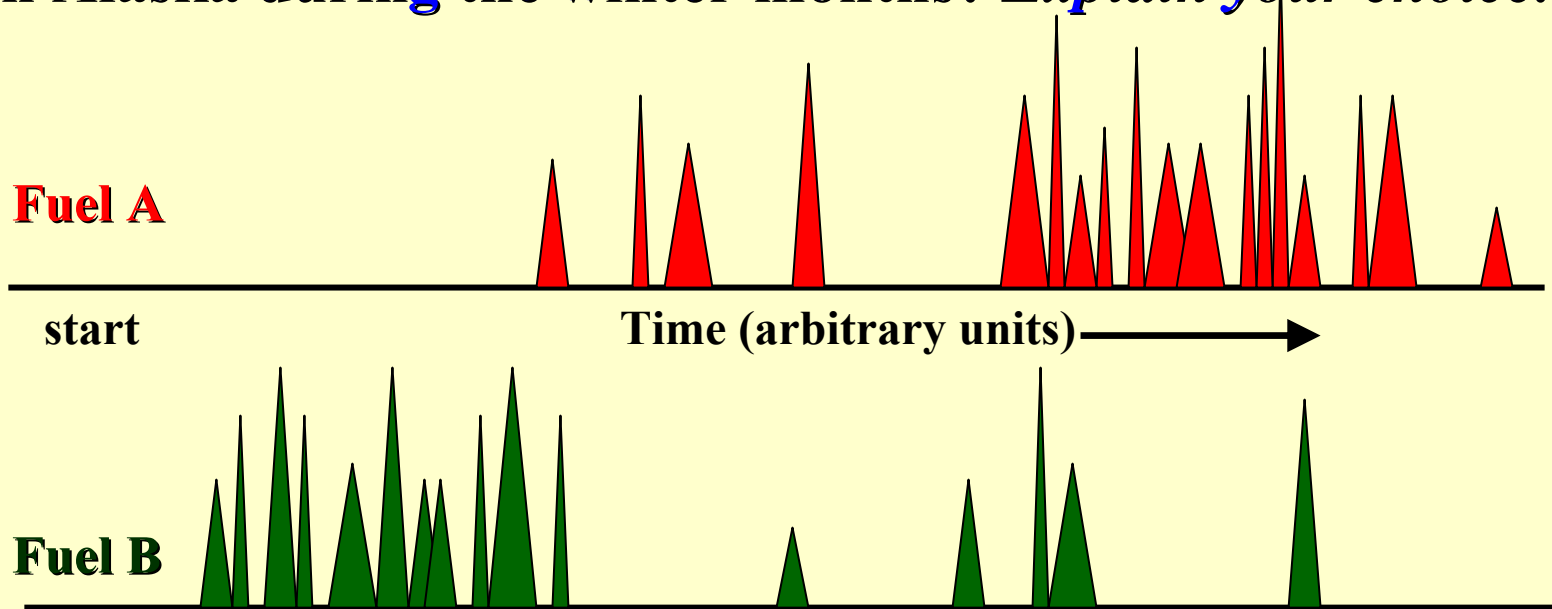


STP[®] Gas Treatment Questions

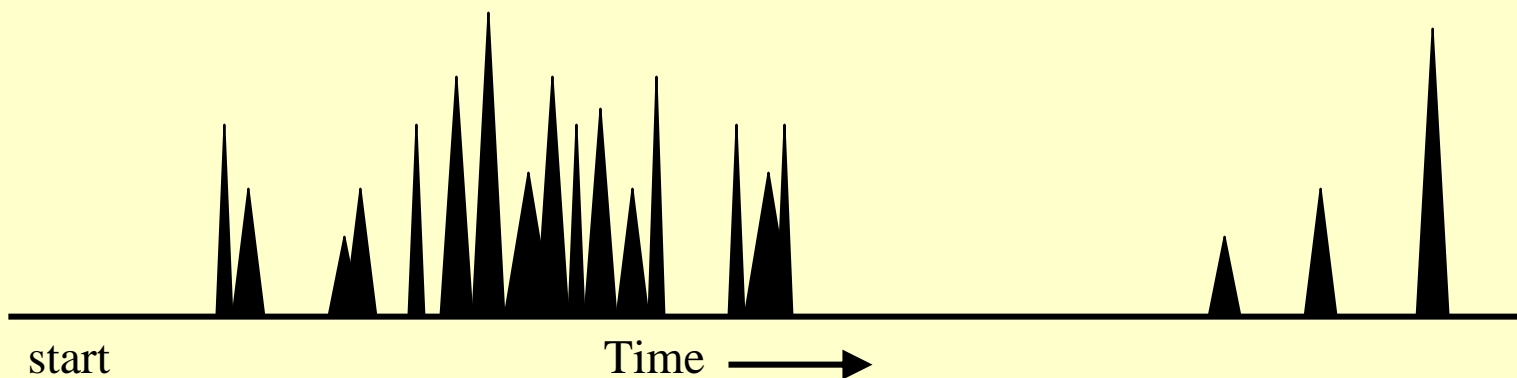


- Which analysis (**GC-1** or **GC-2**) was done at the higher T_{oven} ?
- Perhaps the two analyses were done at the same T_{oven} . If that's the case, then something else must have influenced the obvious difference in resolution and R_f . Was the capillary column used in **GC-2** more or less polar than that used in **GC-1**?
- Perhaps neither T_{oven} nor the column were different. Would a difference in T_{inj} result in the two different chromatograms?

All fuels are volatile; some though are more volatile than others. The vapors from street-grade gasoline are ignited by a spark plug to start a car even in the coldest of temperatures. The two chromatograms below are for two different fuels. Both fuels were injected into the same GC operating at identical conditions. Based on the chromatograms which fuel- **A** or **B**- is the best choice for use in Alaska during the winter months? *Explain your choice.*

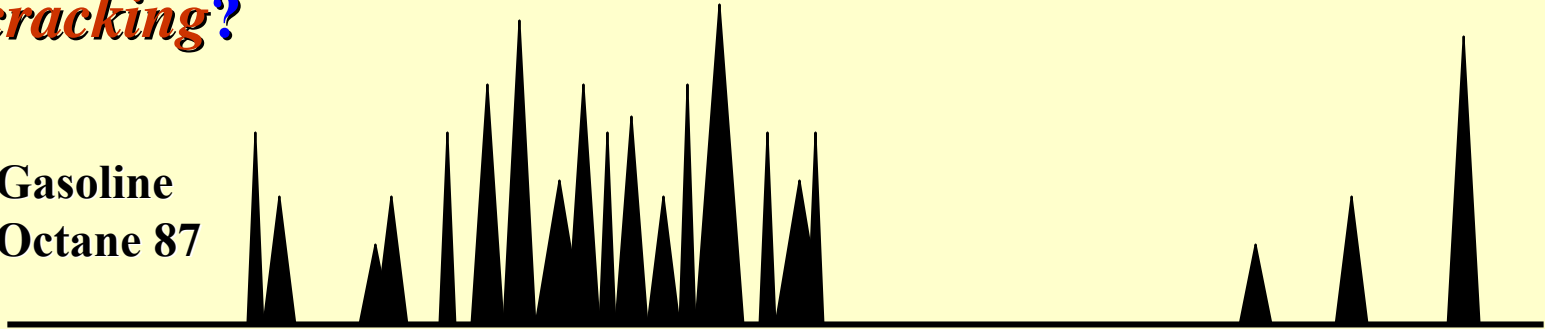


Part of the petroleum refining process involves adjusting the percentage of each fraction of gasoline to match the market demand. For example, there is more demand for gasoline than kerosene or diesel fuels. Refiners use chemical reactions to convert some of the larger kerosene fraction molecules into smaller molecules in the gasoline range in a process called *catalytic cracking*. This was described in detail in the video shown the first week of class. The *catalytic cracking* process uses a catalyst, heat, and high pressures to break longer-chain hydrocarbons into shorter-chain hydrocarbons. Suppose the chromatogram below represents gasoline (Octane 87).

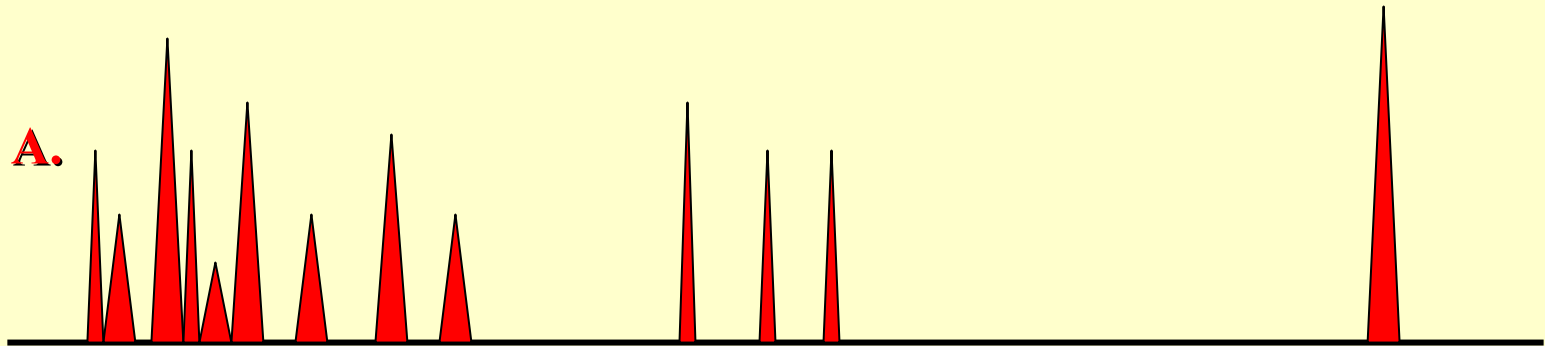


Which chromatogram **A.** or **B.** represents the kerosene fraction from which gasoline is derived using *catalytic cracking*?

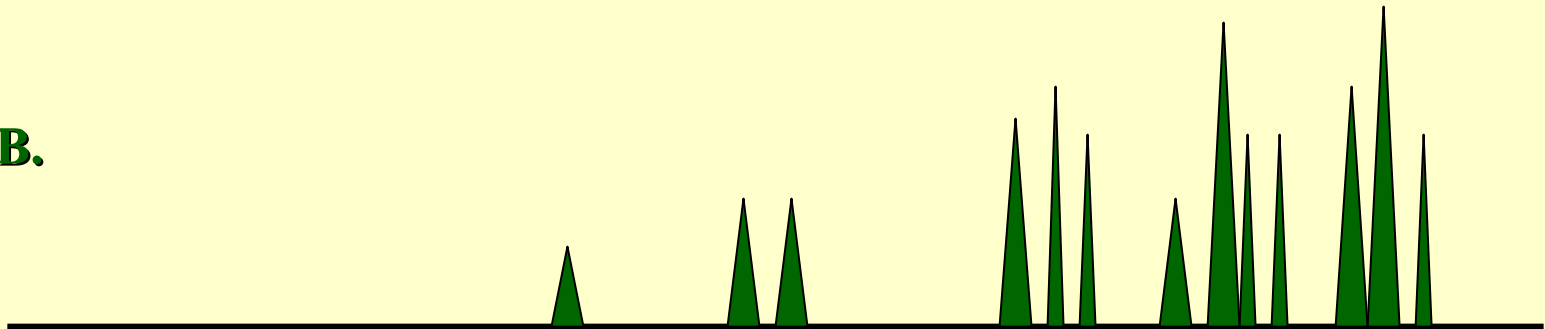
Gasoline
Octane 87



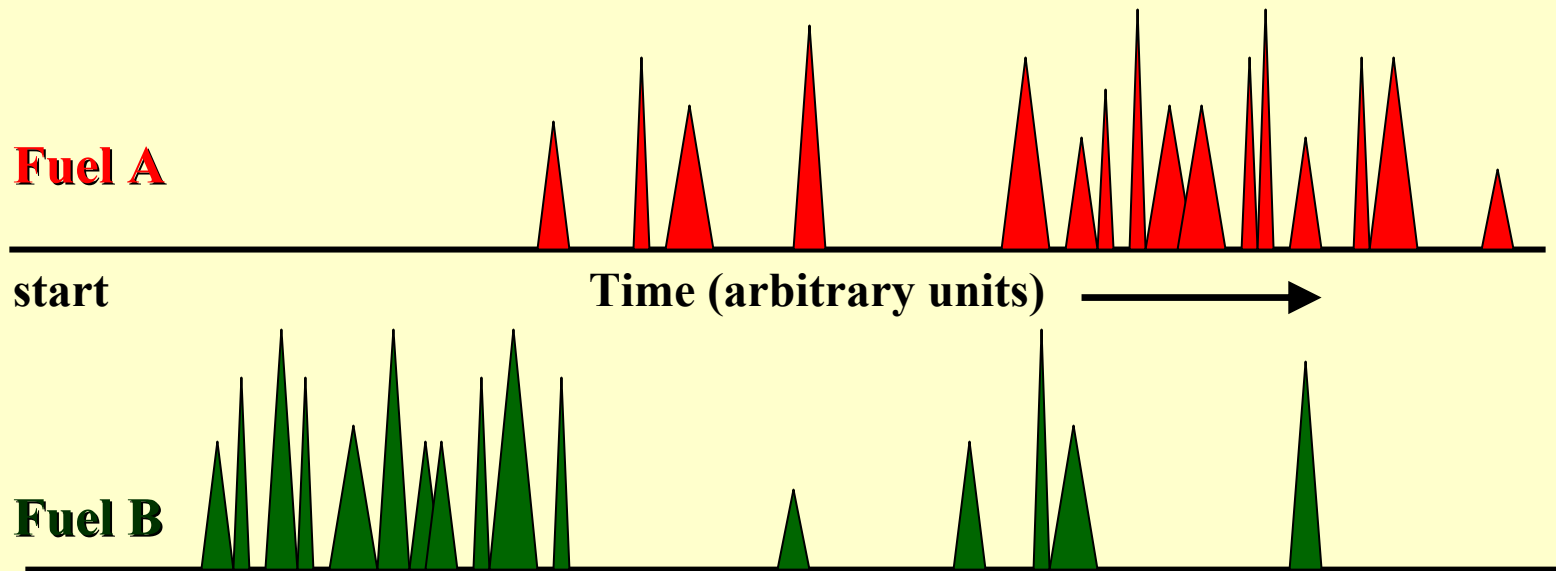
A.



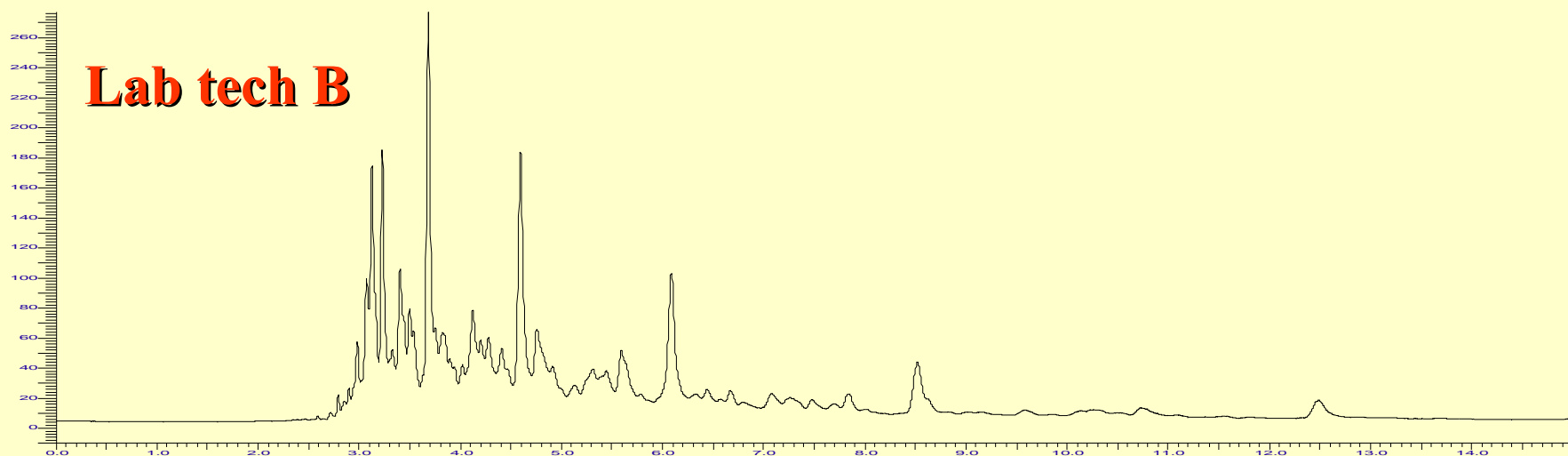
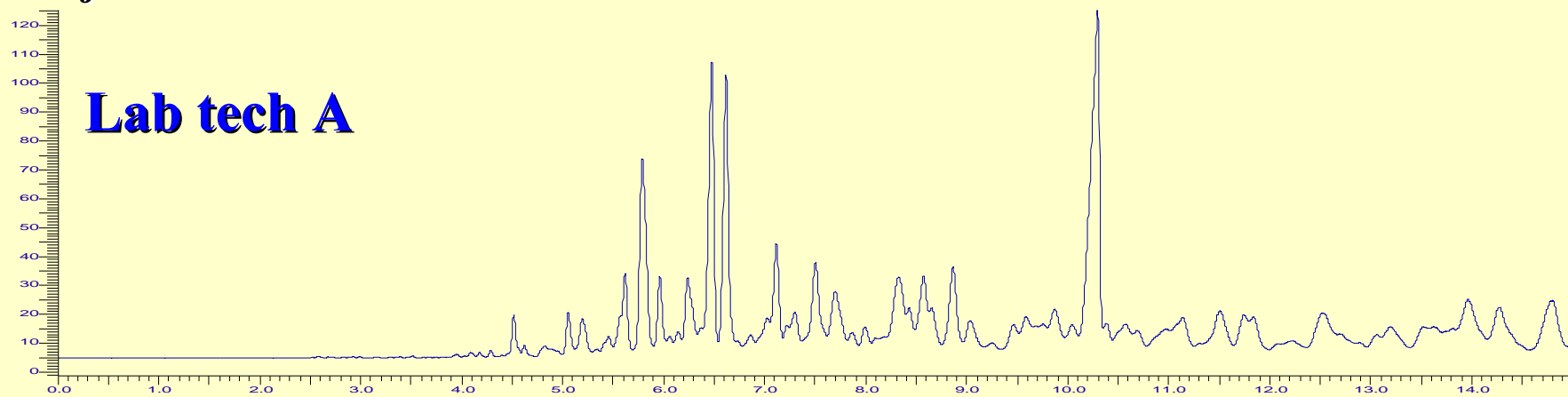
B.



Reformulated gasoline contains a lower percentage of aromatic hydrocarbons and has a lower volatility than regular street-grade gasoline. Cities with serious gaseous ozone (O_3) pollution problems are required by the amendments of the 1990 Clean Air Act to sell reformulated gasoline. Which fuel- **A or **B**- below would best represent reformulated gasoline? *Give an explanation for your choice.***



Lab tech A began a GC analysis of STP[®] Octane Booster then went to lunch. Shortly thereafter, **Lab tech B** did an analysis on the sample as well. The chromatograms are below. What two possible adjustments were made by **Lab tech B** that explains the differences in the chromatograms? *Offer a brief but thorough explanation for each adjustment.*



GC Survey Results

Not confident

1

2

confident

3

4

very confident

5

How confident are you in explaining to another student the basic principles of factors that make a GC work? **Average Rating score: 3.6**

How confident are you in explaining a chromatogram to someone else? **3.8**

How confident are you in explaining in enough detail the basic GC hardware components? **3.0**

How confident are you in understanding the factors that influence the physical separation of compounds in a GC? **3.6**

If a job became available in a lab this summer and it required experience in using GC and interpreting chromatograms, how confident would you be applying for the job? **3.5**

GC Survey Results

**Did the persistent use of the instruments
increase your interest level in science
either as a major or career choice?**

YES

NO

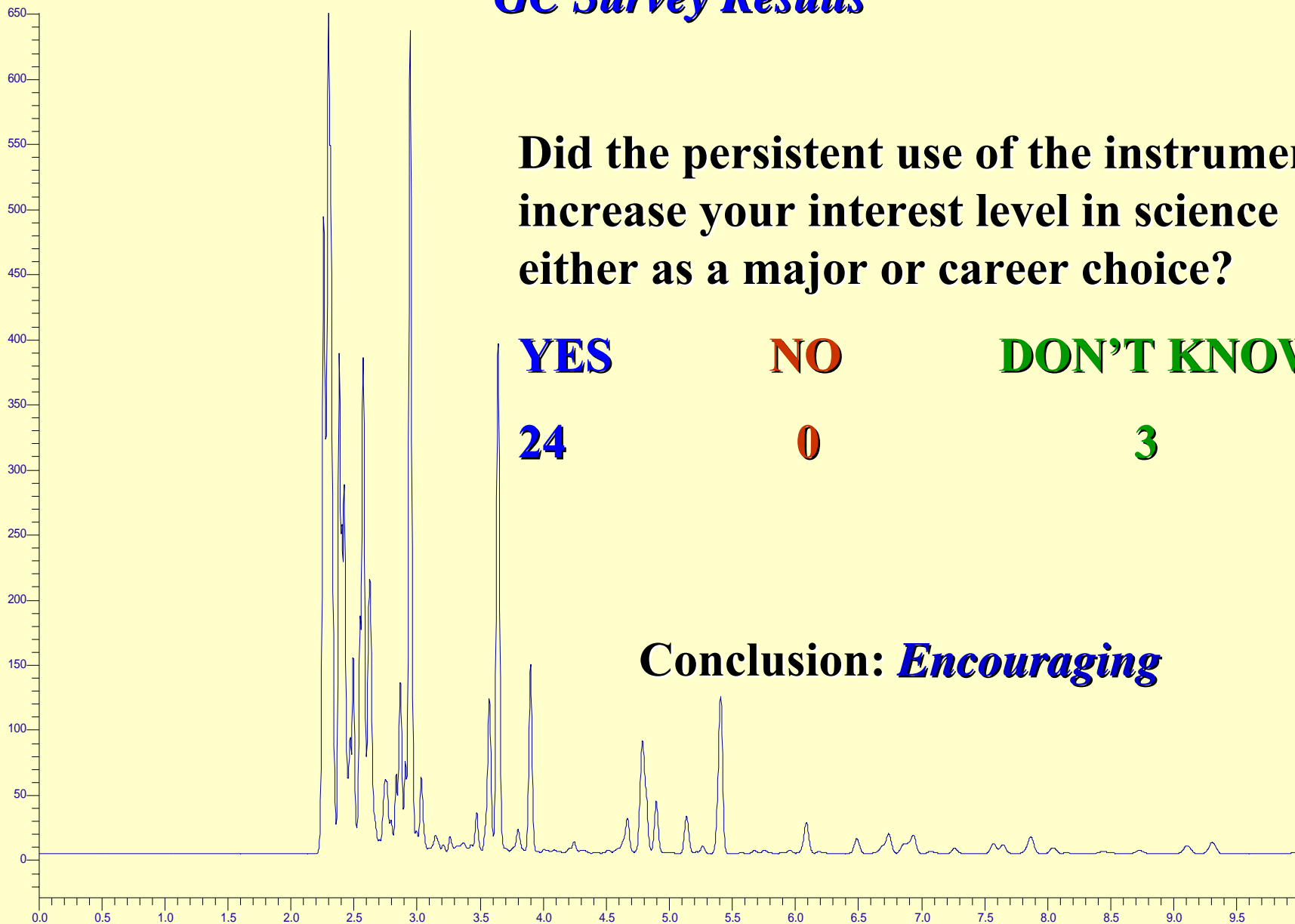
DON'T KNOW

24

0

3

Conclusion: *Encouraging*



Future Analysis?

- **New vs. Used Engine Oil (T_{oven} programming)**
- **Brake Fluid**
- **Diesel Fuel**
- **Aviation Fuel (MCAS & Harrier Jets)**
- **Gasoline from Mexico**
- **Oxidative (air) stability of street-grade gasolines and diesel & aviation fuels**
- **Qualitative comparative analysis of other fuel products- Gumout[®], Snap[®], Gas Tech[®], Berryman[®] B-12, etc.**
- **Fragrant coffees**

Acknowledgements

- 1) National Science Foundation (NSF)
•Course, Curriculum, &
Laboratory Improvement (CCLI)
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- 2) All my students**