

Effects of Molecules on Retention Times

Inquiry Version

PA State Standards for Science and Technology Addressed:

3.2.10.B Apply process knowledge and organize scientific and technological phenomena in varied ways.

Describe materials using precise quantitative and qualitative skills based on observations.

3.7.10.A Identify and safely use a variety of tools, basic machines, materials and techniques to solve problems and answer questions.

3.7.12.A Apply advanced tools, materials and techniques to answer complex questions.

Demonstrate the safe use of complex tools and machines within their specifications.

Introduction:

There are several factors that effect the retention time of a molecule during a gas chromatography experiment. Some of these factors include the size of the molecule, the shape of the molecule, and the polarity of the molecule. By keeping any two of the three constant, the effect of the third factor on the retention time can be examined.

Purpose:

The purpose of this experiment is to determine the effects of size, shape, and polarity of a molecule on the retention time using gas chromatography.

Equipment/Materials:

Gas Chromatograph	ethanol
Computer	n-propanol
Printer	n-butanol
Syringe	sec-butanol
Kimwipes	iso-butanol
methanol	tert-butanol

Safety:

- Always wear an apron and goggles in the lab.
- DO NOT misuse the syringes. These are very dangerous, especially when filled with hazardous chemicals.
- The gas chromatograph is like an oven, so the ports and top of the instrument may be hot. Use with caution.

Procedure: Set-up and Use of the GC

1. Turn on the GC and start the Peak Sample software. A data acquisition system popup should appear with phrases like initializing, waking up, signing on, setting modes, and calibrating. If you get a popup saying can't wake – check power and cable, try one of the following options.
 - a. Check to make sure that the cable between the GC and computer is properly attached and that the GC is on.
 - b. Close the program. Unplug the USB cord from the computer, then plug it in again. Restart the program. If it still won't wake, try the next option.
 - c. Click on the Edit Menu, then select Overall. In the COM Port/USB device number box, try a number from 1 – 5. Keep trying until the data acquisition system begins to function.
2. Click on edit menu, then select channels. Under Channel 1, pick Temperature. Click on the numbers to highlight them, then click Change. Change the numbers as follows:
 - Start 150°C
 - Hold 20 minutes
 - Ramp 0 degree / min
 - Until the temperature is 150°C
3. Be sure the time scale starts at zero and ends at 20 min. Use the arrows to adjust.
4. Clean the syringe by rinsing it 10 -- 15 times with one of the samples. With the plunger fully depressed, place the needle into the sample. Slowly draw up the plunger to obtain a sample in the syringe. Remove the syringe from the sample. Discharge this sample into the sink or onto a Kimwipe. Depress the plunger, and put the syringe needle back into the sample. Draw up a second sample and discharge it. Repeat. **Do not push on the plunger when the needle is inside a sample.**
5. Place the syringe needle back into the sample and withdraw over 1 microliter. Remove the needle from the sample bottle, then depress the plunger to the 1 microliter line. Wipe the needle with a Kimwipe.
6. Click on the Z or θ button on the run screen to zero the current.
7. Insert the needle carefully into the injection port of the GC until the entire needle is inside the instrument.
8. Inject the sample and start the data collection simultaneously by depressing the syringe plunger and pressing the space bar on the computer at the same time.
9. When the sample peak returns to baseline, the run may be stopped by pressing the end button on the computer. After pressing end, print the graph. Be sure to label the graph.

Experiment:

Determine the effects of molecular size and shape on retention time.

Questions:

1. Compare and contrast the first four structures in the data table. What conclusions can be made concerning the retention time and molecular size?
2. Compare and contrast the last four structures in the data table. What conclusions can be made concerning the retention time and molecular shape?
3. Predict which molecule would have a longer retention time and explain why:
 - a. octane or octanol
 - b. decane or octane
 - c. n-propanol or 2-propanol
 - d. 2-propanol or ethanol
4. What other factors could effect retention times of molecules?