

Detection of Chemical Isomers with Gas Chromatography

In this experiment, students use gas chromatography to identify and isolate the structural isomers *o*-xylene and *p*-xylene.

ESTIMATED TIME

We estimate that this experiment can be completed in one, 3-hour class period.

TIPS

1. In the Electronic Resources you will find PDF and word-processing files of the student experiment. You can print the PDF, distribute it to students electronically, or post the file to a password-protected class web page or learning management system. Edit the word-processing file if you would like to tailor the experiment to suit your equipment and students. Sign in to your account at www.vernier.com/account to access the Electronic Resources.
2. We recommend keeping back-up vials of each compound in addition to the vials that are made available to the students; if a student contaminates a vial by mistake or spills a compound, the back-up vials can be used as replacements.
3. We strongly recommend using reagent grade compounds for the best, most reliable results.
4. Vials must be kept tightly sealed when not in use, as the compounds used in this experiment are highly volatile and will evaporate quickly.
5. All of these compounds should be used in a well-ventilated area. Be familiar with the SDS information for each compound and follow safe handling practices.
6. As an alternative to using the Peak Integral feature of the software, students can manually determine the retention time for a compound by using the Examine feature (simply click or tap the graph to view the x- and y-values for each data point). Because of the manner in which the Mini GC operates, the retention time is the x-value, in minutes, at the maximum y-value of the peak. If you want students to use the Examine feature, consider modifying the student version of the experiment.
7. The temperature-pressure profile is set so that each data collection run will last 15 minutes. You may remind your students that some of the substances will have passed through the column and detector well before the allotted time and they can stop the data collection early to save time.
8. It is important that students inject a consistent volume for each test.

Experiment 4

- To make the experiment more quantitative, add n-hexane to each isomer sample. Have students determine the retention time of each isomer from the n-hexane peak.
- To optimize the reproducibility of your retention times, it is best practice to let the Go Direct Mini GC return to 45°C between each trial.
- For the extension, prepare a sample of BTEX (benzene; toluene; ethylbenzene; and *o*-, *m*-, and *p*-xylenes) by combining 1.0 mL benzene, 1.0 mL toluene, 1.0 mL ethylbenzene, and 0.3 mL *o*-xylene. Note that *p*-xylene and *m*-xylene are omitted from the mixture. *p*-xylene cannot be separated from ethylbenzene in the Go Direct Mini GC.
- Note that this experiment requires the Go Direct Mini GC (order code: GDX-GC). The compounds used in this experiment are not detectable on the Mini GC (order code: GC-MINI) or Mini GC Plus (order code: GC2-MINI).

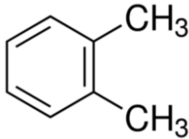
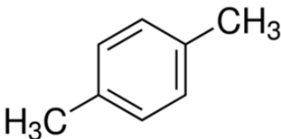
HAZARD ALERTS

The chemical safety signal words used in this experiment (**DANGER** and **WARNING**) are part of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). Refer to the Safety Data Sheet (SDS) that came with the chemical. These can also be found online from the manufacturer. See the Preface for additional chemical safety information.

n-Hexane, C₆H₁₄: **DANGER**: Keep away from heat, sparks, open flames, and hot surfaces—highly flammable liquid and vapor. Do not eat or drink when using this product. Avoid breathing mist, vapors, or spray. May be fatal if swallowed and enters airways. May cause damage to organs. Causes skin and eye irritation. May cause drowsiness or dizziness. Suspected of damaging fertility or the unborn child. Do not handle until all safety precautions have been understood. Use personal protective equipment as required.

Xylene, C₆H₄(CH₃)₂: **WARNING**: Flammable liquids. Flammable liquid and vapor. Keep away from heat, sparks, open flames, and hot surfaces. May be harmful if swallowed. Causes skin irritation. Harmful if inhaled.

PRE-LAB ACTIVITY

Compound	Boiling temperature (°C)	Molar mass (g/mol)	Chemical structure
<i>o</i> -xylene	144.4	106.16	
<i>p</i> -xylene	138.4	106.16	

SAMPLE DATA

Compound	Retention time (min)	Peak area
<i>o</i> -xylene	6.80	1200
<i>p</i> -xylene	6.10	100
<i>o</i> -xylene in mixture	6.62	210
<i>p</i> -xylene in mixture	6.05	120

SAMPLE CHROMATOGRAMS

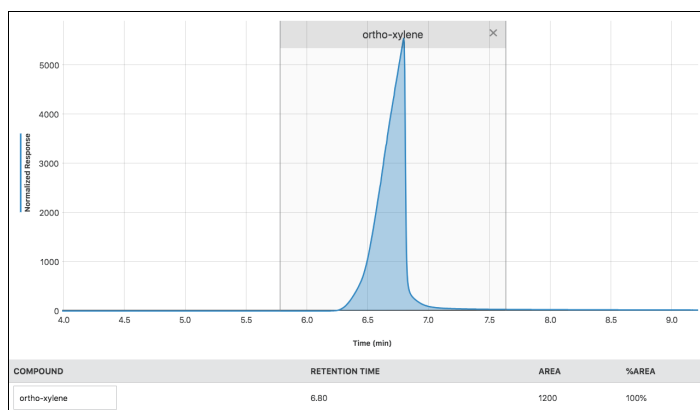


Figure 1 Sample chromatogram of o-xylene

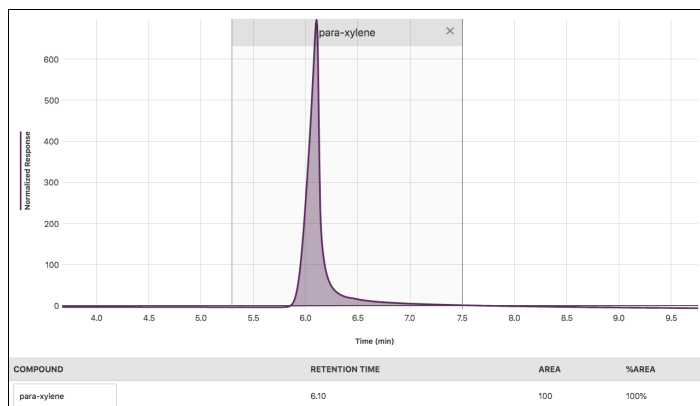


Figure 2 Sample chromatogram of p-xylene

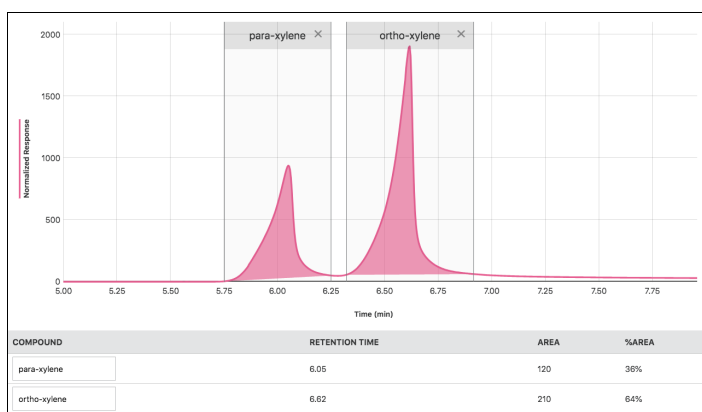


Figure 3 Sample chromatogram of xylene mixture

ANSWERS TO ANALYSIS QUESTIONS

1. *p*-Xylene is the first peak in the mixture; *o*-xylene is the second peak.
2. See Sample Data.

EXTENSION

BTEX can be obtained with the following temperature-pressure profile. Note that *m*-xylene is omitted from our mixture.

Start temperature (°C)	30
Hold time (min)	0
Ramp rate (°C/min)	5
Final temperature (°C)	95
Final hold time (min)	2
Pressure (kPa)	11

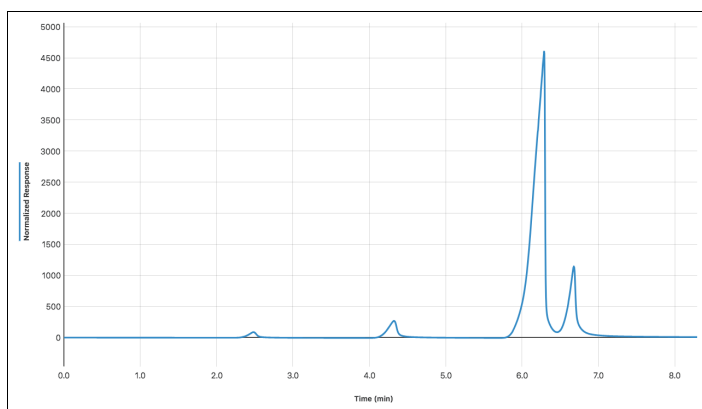


Figure 4 Sample chromatogram of BTEX mixture