## Unsolved Mysteries of Human Health

# Gas Chromatography / Mass Spectrometry (GC/MS)

## Instructor Guide

**"The Answers Are Blowing in the Wind"**
**Scenario Overview**


- It's a beautiful spring day.
- Mary's Peak has a view of the ocean on the west and the valley and mountains on the east.
- Haze is visible, so the view is obstructed.
- What could be causing the haze?

**Scenario Facts**

- The lab of Staci Simonich at Oregon State University collects air samples at the top of Mary's Peak to study the air quality.
- This air sampler pulls in about one cubic meter of air each minute.
- Over 24 hours they collect 1440 cubic meters of air. That's about the volume of a 50-meter swimming pool.
- Air samplers have filters. Any dust in the air is trapped on the filter.
- The sample is taken back to the lab to measure what chemicals are in the air – They can measure them at very low concentrations (trace amounts).
- Looking at weather data helps in the investigation to see the direction of airflow.
- The chemicals in the air causing the haze is either coming from the east or the west. Retene would be present if the airflow was from the east, and DDT would be present if the airflow was coming from the west.
- A GC/MS instrument is used to identify trace amounts of chemical in the air.
- To identify the chemical, a standard mass spectrum is compared to the mass spectrum of the sample.
- Students solve the problem based on comparing mass spectrums.

**Learning Outcomes**

***After completing the module, students will be able to*** share how scientists take air samples, measure trace chemicals from the sample, and identify what chemicals are in the air.

**Student will be able to define the following vocabulary:**
http://unsolvedmysteries.oregonstate.edu/glossary

- **Volatility**
- **Troposphere**
- **Gas chromatograph**
- **Mass spectrometer**
- **Standard**
- **Retene**
- **DDT**
- **Accelerated solvent extractor**
- **Molecular ion**
- **Fragment ions**
- **Computer model**

**Parts of the GC/MS Instrument - Script**

1. **Gas chromatography (GC)**
    - **Injection port** – One **microliter** (1 µl, or 0.000001 L) of solvent containing the mixture of molecules is injected into the GC and the sample is carried by inert (non-reactive) gas through the instrument, usually helium. The inject port is heated to 300° C to cause the chemicals to become gases.
    - **Oven** – The outer part of the GC is a very specialized **oven**. The column is heated to move the molecules through the column. Typical oven temperatures range from 40° C to 320° C.
    - **Column** – Inside the oven is the **column,** which is a 30-meter thin tube with a special polymer coating on the inside. Chemical mixtures are separated based on their volatility and are carried through the column by helium. Chemicals with high volatility travel through the column more quickly than chemicals with low volatility.

2. **Mass Spectrometer (MS)**
    - **Ion Source** – After passing through the GC, the chemical pulses continue to the MS. The molecules are blasted with electrons, which cause them to break into pieces and turn into positively charged particles called **ions**. This is important because the particles must be charged to pass through the filter.
    - **Filter** – As the ions continue through the MS, they travel through an electromagnetic field that filters the ions based on mass. The scientist using the instrument chooses what range of masses should be allowed through the filter. The filter continuously scans through the range of masses as the stream of ions come from the ion source.
    - **Detector** – A detector counts the number of ions with a specific mass. This information is sent to a computer and a **mass spectrum** is created. The mass spectrum is a graph of the number of ions with different masses that traveled through the filter.

3. **Computer**
    - The data from the mass spectrometer is sent to a computer and plotted on a graph called a **mass spectrum**.