Was It a Drug Bust?

A police officer knocked on the door of the house and presented a search warrant. Other officers surrounded the house and arrested two suspects as they tried to flee. Inside, the police found bag after bag of white powder.

The officers suspected that the bags contained methamphetamine, called *meth* for short. Meth is a dangerous drug that gives users a temporary high but damages every part of the body that it touches. For a drug, meth is a simple molecule. It has 10 carbon atoms, 15 hydrogen atoms, and 1 nitrogen atom, as shown in Figure S4.1. If a sample of meth is “pure,” then all the molecules in the sample will have this exact same structure.

One of the suspects immediately claimed that the bags contained ground-up aspirin. He said that he ground the aspirin to make pastes for his grandmother’s aches and pains. How could the officers find out if the suspect was telling the truth?

**On-the-Spot Testing**

The officers began their analysis with a testing kit they had brought with them. Their test involved mixing a few drops of chemicals from the kit with the unknown substance. As you can see at the top of Figure S4.1, meth has a nitrogen (N) sandwiched between two carbons (C). Any molecule with that shape would react in this test to create a new, bright-orange molecule. Aspirin does not have nitrogen and won’t turn orange.

This test works because identical molecules of a chemical will always have the same properties. Molecules with identical molecular structure will react the same way with other molecules, catch fire at the same temperature, and break apart in stomach acids at the same rate. If a molecule goes through any of these processes, the molecule changes. Properties that can only be discovered by changing the molecule are called chemical properties.

Unfortunately for the suspect, the powder turned bright orange when it was tested, showing that at least part of the molecule was the right shape to be meth. The police sent another sample to a drug lab for more testing.

Most illegal drugs are not pure. They may contain several different chemicals mixed together, some of which can be even more dangerous than the drug being purchased. The first step in a drug lab is to separate the different chemicals in the sample.
A technician at the lab fed the sample sent by the police into a machine called a gas chromatograph, or GC for short. When a sample is placed in a GC, it is first heated until it reaches its boiling point and becomes a gas. Then the gas floats through a long tube that is about the length of three school buses. The tube is twisted tightly so it will fit in the machine. As shown in Figure S4.2, molecules move through the tube at different speeds. Because the tube is so long, different molecules reach the end at different times. Small molecules with a low boiling point tend to move through the fastest, whereas large molecules with a high boiling point move more slowly.

Molecule size and boiling point are physical properties, or properties that can be tested without changing the molecules. Therefore, the GC sorts the chemicals by their physical properties.

Figure S4.2. Molecules Move Through the GC at Different Speeds

Researchers in drug labs know how long it should take different molecules to travel through their machines. For example, cocaine is a large molecule. It takes 13.5 minutes to travel through certain machines. On the same machines, meth zips through in just 5.1 minutes.

The powder from the crime scene? It popped out in 5.1 minutes. This result indicated that the chemical might indeed be meth. But the identification process was not complete because closely related molecules can travel through the GC at similar times, so one more step was needed to identify the powder.

Identifying White Powder

After GC analysis, molecules from a sample move straight from the GC into another machine called a mass spectrograph, or MS. An MS breaks the molecules into chunks, as shown in Figure S4.3 (p. 56). Molecules break up into chunks the same way every time. This is another chemical property because it definitely changes the molecules involved. Once again, the chunks travel through a long tube.
As the chunks exit the MS, the machine records their masses. It prints a graph of how many chunks of each size were in the sample. If the sample is meth, the biggest chunks will have a molecular mass of 134, 91, and 58.

The technician working on the possible meth sample checked the data as the sample rolled through the MS. A few minutes later, she had the readout of the molecular mass: 134, 91, and 58.

She marked the sample “Methamphetamine” and carefully filled out her paperwork. This was nobody’s grandma’s aspirin, and this evidence would make sure the police could prove it in court.

**The Big Question**

Look back at your lab. You tested two groups of properties. Which group contained physical properties? Which set were chemical properties? How do you know?