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CSI Chemistry: Clue Me In
Background Information

Background Information: Investigators and forensics scientists are often faced with a jumble of facts and evidence that seem to be unconnected. It is the job of the investigators or forensic scientist to organize, analyze and determine the relationship between different pieces of evidence to reconstruct the crime in order to solve it. The process that they use is known as **deductive reasoning**. Deductive reasoning can be considered a top-down approach to problem solving. In deductive reasoning, observations lead to a theory. A hypothesis is then formed and more information is systematically gathered and tested against the hypothesis. If they evidence agrees with the hypothesis, the theory is supported.
If the evidence does not agree with our hypothesis, a new theory is developed and the process repeats itself.
A simplified example of deductive reasoning is illustrated in every episode of forensics television shows. First, the lead forensic scientist and his forensic team survey the crime scene and come up with a theory about how the crime happened. They take the available evidence and come up with a hypothesis. This hypothesis is tested against the evidence available and more evidence is sought to support the hypotheses. If the new evidence supports the hypothesis, then it is pursued. If the evidence doesn't support the hypothesis, a new hypothesis is proposed and the process repeats itself. Since the show is only 45 minutes long, they make the process seem relatively easy. In real life, this process can take months and the investigators can go through many hypotheses before they arrive at the correct one and apprehend the perpetrator. The process of deductive reasoning is also used to solve problems in chemistry.

The chair you are sitting on, the paper you are reading, the clothes you are wearing and everything around you is made of **matter.** All matter is made of **elements** or combination of different elements. Elements are the basic building blocks of matter. They cannot be broken down into simpler substances by using physical or chemical means. Very few elements are found in the earth in a pure form without being combined with other elements. As a result, very few elements were known to ancient civilizations. The elements that the ancients did know included gold, silver, copper, iron and lead. It wasn't until the late 1700's that scientists had the knowledge and the methods to isolate previously undiscovered elements from their mineral sources. As the number of known elements increased, chemists noticed that some elements had similar properties. Scientific discussion revolved around the question of "Is there a pattern?" One of the first chemists to notice a pattern was Antoine Lavoisier. Lavoisier was a French chemist and is often referred to as the father of modern chemistry. In the late 18th century, he organized the known elements into two groups, metals and nonmetals. Then in 1829, a chemist by the name of **Johann Dobereiner** arranged the elements into groups of three, called triads. Elements in each triad had similar chemical and physical properties. However, as more elements were isolated, there were many that would not fit in these triads. **John Newlands** organized the elements in order of increasing atomic weights. When this was done, he noticed that the properties repeated after every eighth element. That is, the first in his scheme was similar in chemical and physical properties to the ninth, the second to the tenth, and so on. His repeating pattern of eight was called the "Law of Octaves," due to is similar to the musical scale. However, it did not account for elements that had not been discovered yet. It also predicted similarities in properties between elements that were not there. Then in 1869, two chemists simultaneously developed the first modern periodic table. The chemists were **Lothar Meyer and Dimitri Mendeleev.** Mendeleev was known to enjoy playing solitaire. One day, he wrote the properties for the known elements on cards. He used one card for each element. Then, much as one would arrange cards to play solitaire, he began to arrange the elements. He finally determined that if he placed the element cards in order of increasing atomic mass a pattern emerged. His arrangement was very convincing and he recognized that there were empty slots for elements that had not yet been discovered. He used the properties of the element around these blank spots in his arrangement to predict the properties of each missing element. Later, when these missing elements were discovered, their properties were very nearly what Mendeleev had predicted years before. Thus, the first modern periodic table evolved. The modern periodic table was developed by **Henry Moseley** in 1934. He arranged the elements in order of increasing atomic number. This eliminated some of the remaining discrepancies in Mendeleev's arrangement.

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Currently, there are about 114 known elements. Each element is represented on the periodic table with a symbol.
For example, the first element on the table, hydrogen, is represented by the symbol, H.
The elements are arranged in 18 **groups** or families (vertical columns) and seven **periods** (horizontal rows).
If the atomic symbol is more than one letter, the first letter is always capitalized and the second one is always lowercase.
Elements in the same group have similar chemical and physical properties.
This is because elements in the same group possess the same number of outer electrons known as **valence electrons**.
Because these groups behave similarly, they are often referred to as families.
The two groups on the left and the six groups on the right are known as the **representative or main group elements.**

They include:

- Group 1: alkali metals
- Group 2: alkaline earth metals
- Group 13: no common name
- Group 14: no common name
- Group 15: pnictogens
- Group 16: chalcogens
- Group 17: Halogens
- Group 18: noble gases

The **alkali metals** are shiny, soft metals that react rapidly with oxygen. When they are placed in water, they react to form metal hydroxides which make the resulting solution basic or alkaline. Due to their reactivity, the alkali metals are never found in nature in their pure elemental state.

The **alkaline earth metals** are also shiny but they are not as soft or reactive as the alkali metals. When the alkaline earth metals are placed in water they also form a basic or alkaline solution. Although they are not as reactive as the alkali metals, they are still not found (in their pure state) in nature by themselves.

The **pnictogens** are called such because their gases are often choking or suffocating. The name for the **chalcogens** comes from the Greek word for ore-former. The **halogens**, found in Group 17, are very corrosive nonmetals. They range in state from gas (fluorine and chlorine), liquid (bromine) and solid (iodine and astatine). They are found in nature bonded to other elements. Fluorine, chlorine, bromine, and iodine will also bond with themselves and are called diatomic elements.

The **noble gases** are called such because they are the most unreactive elements in the periodic table. They are all gases at room temperature and, due to their inert nature; they are often used as a "blanket" to keep other elements from reacting with oxygen. For example, incandescent light bulbs are often filled with a noble gas, such as argon, to prevent the filament from reacting with oxygen.

The groups located in between the representative elements are called the **transition metals**.

The groups that lie below the others on the periodic table are called the **inner transition metals**.
Elements can be classified as **metals, nonmetals, and metalloids**.
The metallic elements are located to the left of the stair step line. Metals are shiny, can be pounded into sheets (malleable), drawn into wires (ductile), and are good conductors of heat and electricity.

Nonmetals are located to the right of the stair-case line. Nonmetals tend to be gases or brittle solids at room temperature. They are also poor conductors of heat and electricity.

The elements located ON the stair-case line are called metalloids. Metalloid elements have both metallic and nonmetallic properties. Take, for example, the element silicon. Silicon is shiny like a metal but brittle like a nonmetal.

Now you will use a blank periodic table to label it with all the distinguishing terminology that you just read about. You will need a blank periodic table outline and some colored pencils.

1. Number the groups 1-18 on the top of each group. Label them Group 1, etc.

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2. Number the periods beside the start of the row. Label them Period 1, etc.

3. On the groups with "special group names", write the group name down the group vertically.
(Actually write over the boxes.)

4. Draw in the staircase line as it appears on the published periodic table.

5. Color the metalloids blue.

6. Color the nonmetals orange.

7. Color the metals yellow.

8. Draw a brown outline around the representative elements.

9. Draw a red outline around the transition metals.

10. Color the inner transition metals purple.