Cosmic Chemistry: Understanding Elements

The Modern Periodic Table

TEACHER GUIDE SUPPLEMENT

READING THE MODERN PERIODIC TABLE

Put a transparency of Mendeleev's periodic table and the modern periodic table on the overhead projector (or give students a copy of each). Ask students to list ways in which they are similar and different. Post these on the chalkboard. Discuss the differences between groups and periods in both tables. Students should then answer questions one and two.

1. Describe how the groups and periods are different in the modern periodic table versus Mendeleev's version.

   In the modern periodic table groups of elements with similar properties appear in vertical columns and periods of increasing atomic number appear in horizontal rows. Mendeleev's table had groups in rows and periods in columns.

2. The modern periodic table is arranged by _____. atomic number

3. Why was the oxide ratio column not shown in earlier Mendeleev periodic tables?

   Possible answer: Mendeleev did not know the oxide ratios for elements.

GROUPS

Describe to students that elements in the same group have similar physical and chemical properties. Choose one group and point out the properties for each element in that group. Students may discuss what known characteristics belong to certain groups of elements. The following laserdisc shows this in video format: (Resource: VideoDiscovery® Chemistry at Work Laserdisc: (http://www.videodiscovery.com) this has a short video clip called "the periodicity of alkali metals." Students can present this type of information to the class if they complete the "Element Research" activity.

1. Why do elements in the same group have similar physical and chemical properties?

   Elements in the same group have the same number of electrons in their outermost orbit.

2. How are the groups titled?

   Either from one to eighteen or with Roman numerals and letters.

3. How many groups are there?

   Eighteen or 16 with Roman numeral method.

4. List all of the elements in group 14 or IV A.

   carbon, silicon, germanium, tin and lead.

PERIODS AND CLASSIFICATIONS

Try using the analogy of locating elements on the modern periodic table to finding a location on a map. Just as people can find a town on a map by using latitude and longitude, elements can be found if their group and period is known. Ask the students for other examples locating items by a coordinate system. How are these analogies different than that of the

periodic table? (With other analogies the position is the important part, with the periodic table the properties are the most important factor.)

1. Periods are arranged in _____ rows. horizontal
2. How many periods are there? seven
3. List all of the elements in period 2.

   lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, and neon
4. What are the three classifications of elements? metals, metalloids, nonmetals
5. Metals are found on the _____ side of the table. Left
6. Name the element in period 4 group IA (1). Potassium
7. Write the atomic symbol for the element in period 6 group IB (11). Au

METALS

In small groups, have students generate a list of metals. Post these on the chalkboard for discussion. Ask: "What makes a metal?" Ask the groups to eliminate any on the list that do not meet this criterion. Next ask the groups to make list some of the uses of the metals left on the chalkboard. Have students share their use list and discuss.

1. List some of the properties of metal.

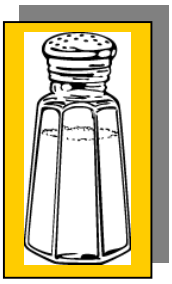
   Metals are dense, have luster, are good conductors of heat and electricity, and are malleable and ductile.
2. Why do metals have a luster?

   Solid metals are crystals formed from positive ions with mobile electrons that reflect light in many wavelengths.
3. Where are the most metallic metals found on the periodic table? On the left side.

For each of the following groups provide either a laminated copy of the periodic table with transparency pens or a paper copy of the periodic table with highlighters. Students can locate and highlight the different groups as the questions are discussed. Students should also develop a color code key for their table.

THE ALKALI METAL GROUP

Sodium can be used to show how reactive Alkali metals can be. For a sodium / chlorine reaction demonstration: http://scifun.chem.wisc.edu/vol1desc.html*. Also if you would like to show a short video of this reaction it can be found on the Windows of Science laserdisc under the physical science section. (*http://www.opticaldata.com/catalog/wos/wosmain.html*)*



1. List the atomic symbols for the elements in this group.

   Li, Na, K, Rb, Cs, Fr
2. Describe the relationship between the atomic number and the chemical reactivity of alkali metals.

   As the atomic number increases the chemical reactivity of the element also increases.

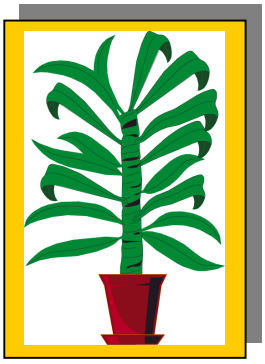
3. When metals in this group react with nonmetals, ionic compounds are formed. The metal loses one electron and becomes a _____ charged cation.

   positively

4. Describe the distribution of the metals in this group.

   Compounds formed by elements in this group are widely distributed.

THE ALKALINE EARTH GROUP



Magnesium ribbon can be used with a Bunsen burner to demonstrate the reactivity in this group. One can also show this by showing a short video on the Chemistry at Work laserdisc.

1. Compare and contrast the bonding and reactive ability of the alkaline earth group to the alkali group.

   Differences: Atoms in this group are held together more tightly than alkali metals.
   Alkaline earth metals are smaller and not as chemically active.
   Alkali metals require special storage because they are so reactive
   Similarities: Both are widely distributed
   Both elements are more reactive as one looks down the group
   Both form bases

2. Describe how calcium and magnesium ions affect water.

   They cause water to become “hard” forming insoluble salts with soap.

3. List the atomic symbols for the elements in this group. Circle those that are of interest to Genesis scientists.

   Be, Mg, Ca, Sr, Ba, Ra (teacher's answers are underlined).

THE TRANSITION METALS

*A good laboratory activity using metals is found in the ChemCom Chemistry in the Community book by the American Chemical Society. In the third edition the activity is called: “Metal Reactivities” See: (*http://www.acs.org/education/currmats/chemcom.html

1. Why is this group also known as the “heavy metal” group?

   Their atoms are relatively small and their large number of protons and neutrons give them relatively large masses.

2. Describe what alloys are and how they are used.

   Alloys are mixtures of metals and are used to produce tools, construction materials, and in automobiles

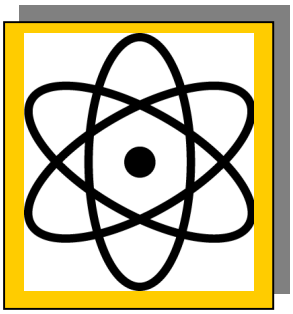
3. Name the three coinage metals. These three metals are good electrical conductors.

   copper, silver, and gold

4. Name the two transition metals that are of most interest to the Genesis scientists.

   titanium and chromium

RARE EARTH METALS



ChemCom's Nuclear Chemistry in Our World is an excellent resource. Subsections include Radiation, Radioactivity, Nuclear Energy, and Living with Benefits and Risks.

1. Name the two periods in this group.

   lanthanides and actinides

2. Why do you think these elements are sometimes found under the rest of the table?

   Possible answer: because they are difficult to find, many are synthetically made

3. When radioisotopes decay they emit _____.

   radiation.

4. Describe the rate at which different radioisotopes decay.

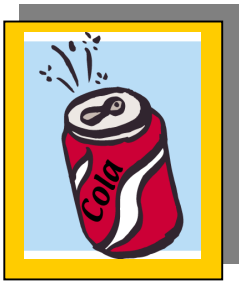
   Some take days or months to decay; others last only a fraction of a second.

5. The most well-known naturally occurring actinide is _____, which can be used in _____.

   uranium, nuclear fission reactions

OTHER METALS AND METALLOIDS

Point out the bold stair step line on most periodic tables. Explain that this separates the metals from the nonmetals. Most of the elements on the border of this stair step are called metalloids. They have the properties of both metals and nonmetals.



1. The staircase inside the periodic table separates the _____ from the _____.

   metals, nonmetals

2. List the atomic symbols for the metalloids.

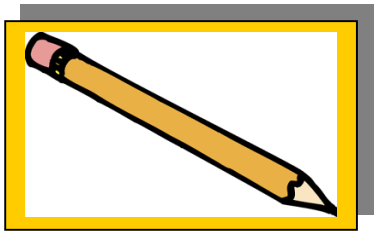
   B, Si, Ge, As, Sb, Te and Po

3. What are semi-conductors and what are their use?

   Semi-conductors are metalloids that conduct electrons in one direction. They are used for transistors and electronic components.

NONMETALS

Another good ChemCom activity for this section is the laboratory activity "Metal, Nonmetal?"



1. Which elements are known as organic chemicals?

   carbon, hydrogen, oxygen, sulfur and nitrogen

2. Most of our atmosphere is made up of _____ gas.

   nitrogen

THE HALOGEN GROUP

Teachers interested in teaching building block chemistry using chlorine should try the Chlorine Chemical Council set of activities at their Web site: http://c3.org/classroom/bbc.html

1. Name the atomic symbols for the elements in the halogen group.

   F, Cl, Br, I, At

2. The word "halogen" means _____.

   salt formers

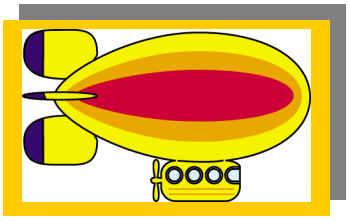
3. Define "salt" in your own words.

   When a halogen bonds with an alkali metal or an alkaline earth metal.

4. Which element is the most reactive element on Earth?

   fluorine

THE NOBLE GAS GROUP (INERT GASES)



Chemistry at Work has two good short videos to accompany this section. One shows the Hindenburg explosion and the other shows one balloon filled with hydrogen and one balloon filled with helium. Both balloons are lit showing the reason hydrogen is no longer used in blimps. Another activity to help students understand question 3 below would be to have students draw Bohr models of each of these atoms and determine what they all have in common. This may indicate the extent that students know about electron configuration and how many electrons can exist at various energy levels. Alternatively students may look up this information on the Web page http://www.chemicalelements.com/. Students can look at the atomic structure of each of the noble gases.

1. List the atomic numbers of the elements in group 0. 2, 10, 18, 36, 54, 86.

2. How was helium discovered?

   Helium was discovered from its bright yellow solar spectral line in 1868.

3. Why do atoms of these elements not react with other atoms?

   Atoms bond when their outer orbits are not full, noble gas elements all have full outer orbits.

4. Which elements' isotope ratios were measured by Apollo astronauts on the moon?

   neon

HYDROGEN

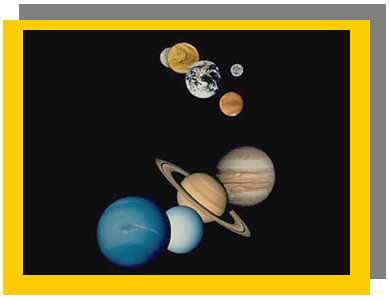
1. After reading the first paragraph in this section, where would you put hydrogen on the periodic table. Explain your answer.

   Answers will vary, some students might put it with the alkali metal group, others might put it by itself away from the other elements because it is such a unique and common element. Students should explain their answer.

2. Describe the basic components of the fusion reaction that occurs in our sun.

   At over 40 million degrees C, hydrogen isotopes deuterium and tritium form a helium nucleus, a neutron, and energy.

ELEMENTAL MYSTERIES FOR GENESIS SCIENTISTS



1. After reading the first paragraph in this section, write down several questions that Genesis scientists hope to answer.

   How abundant are various isotopes of elements in the solar wind?
   Why is there a difference in the isotopic ratios between the sun and the planets?

2. Why do scientists want to know about the ratios of solar oxygen isotopes?

   To find out why there is a variation in oxygen isotopes between the planets and the sun.

3. How might knowing the solar nitrogen isotope amounts bring about more questions?

   If the chemists are correct, the physicists would have to develop a mechanism to explain how the sun's nitrogen isotopic amount has changed over time.
   If the chemists are wrong, they will have to change their way of thinking about solar system formation.

4. How will the Genesis mission provide new data about the noble gases?

   It will provide isotopic composition of the solar wind for the first time.

5. Why is it important that the solar wind samples be measured with ultra clean collector materials?

   If there are contaminants, then their data will not be as accurate.