THE PERIODIC LAW

17

The present organization of the elements is a product of the first periodic table published by Dmitri Mendeleev in 1869. The amazing accuracy of his predictions has been very important to chemists in this century. However, the basis of his arrangement was the atomic masses of the elements. This approach proved incorrect as it would have placed some elements in a family with dissimilar properties. Henry Moseley rearranged the table on the basis of the atomic numbers of the elements. In accordance with Moseley's revision, the **periodic law** states: *the properties of the elements are periodic functions of their atomic number.*

Each of the 106 known elements has its own set of characteristic properties. These range from solid to gas, lusterous to dull, low to high melting points, various colors, and so on. The elements are arranged within the periodic table into groups or families (vertical columns) and periods or rows (horizontal rows). This arrangement reflects the periodic or repeating nature of the properties of the elements.

In this experiment, you will use your knowledge of periodic properties and a list of clues to correctly arrange the elements from a scrambled periodic table. You will also predict values for any information missing from the table.

Objectives

In this exercise, you will

- arrange the elements in Groups IA-VIIIA according to a list of clues and your knowledge of periodic properties;
- predict the missing properties of each element based on location in the table; and,
- explain the trends of properties in families and periods.

EQUIPMENT

scissors
glue
blank periodic table

PROCEDURE

1. Locate Table 17-1 on page 237 of the Appendix. (Your teacher may provide a scrambled table for you.) Each block on the table represents a different element from Groups IA-VIIIA.
2. Cut out blocks A-Z. Use the following clues and arrange the elements in their proper order on Table 17-2 or blank table provided by your teacher. When you have placed these 26 elements in their correct position, glue them to Table 17-2, page 239.

   The following elements belong together in groups: *ZRD PSIF JXBE LHT QKA WOV GUN YMC.*

   J has an atomic number three times that of *T*.
   U has a total of six electrons.
   I_2A is the simple formula of an oxide.
   P is less dense than *S*.
   S is an alkali metal.
   E is a noble gas.
   W is a liquid.
   Z has the smallest atomic mass in its group.
   B has ten protons.
   O has an atomic number larger than *V*.
   R has the largest atomic mass of its group.
   C has five electrons in its outer energy level.
   F is a gas.
   X has an atomic number one higher than *F*.
   L is an alkaline earth element with atomic mass of 40.
   Y is a metalloid.
   O is a halogen.
   The atomic mass of *T* is more than that of *H*.
   Q has an atomic mass 2 times that of *A*.
   Atoms of *I* are larger than those of *S*.
   M has an atomic number one less than that of *A*.
   The electrons of atom *N* are distributed over three energy levels
   The atomic radius of *K* is the largest of the group.
3. Cut out the remaining 16 blocks. Use the information provided in each block and your

knowledge of periodic properties to arrange these elements in their proper position on Table 17-2. Glue the blocks in place.

4. Some information is missing from each block. Predict the values for the missing items from the location of the element on the periodic table. Place your predictions on the table. (You may use the periodic table on the back inside cover only to determine the symbol for each element.)

CONCLUSIONS

1. Examine your completed table. What general observations can be made of trends within rows and groups for the following properties.
   a. density
   b. atomic radii
   c. melting point
2. Where are the heavy metals located? Give three examples.
3. List four physical properties which distinguish metals from nonmetals.
4. List the reason for the location of sodium in the periodic table.
5. Explain the relationship of oxidation numbers to electron configuration for Groups IA through VIIIA. How can an atom's electron configuration be predicted on the basis of its location in the periodic table?
6. Compare a corrected form of Table 17-2 with your table. (Your teacher will provide the corrected table.) Circle any elements that you placed in the wrong position. Describe the accuracy of your predictions for the missing values.

FURTHER INVESTIGATIONS

1. Observe samples of the elements in Period III and Group IA. Set up a table for these elements which contains data on the following physical properties: form and appearance, hardness, melting point, boiling point, density, and electrical conductivity. Use Table A-4 in the Appendix as a reference. On the basis of your observations explain why these properties are called periodic.
2. Prepare a graph of the atomic radii of the first 20 elements in the periodic table. Let the vertical axis represent the length of the radius in nanometers. Start with 0.050 nm and let each square represent an increase of 0.010 nm. Let the horizontal axis represent atomic number, with each block increasing in value from one to twenty. Use Table A-4 in the Appendix as a reference. Explain why the length of an atom's radius is considered to be a periodic property.

Table 17-1

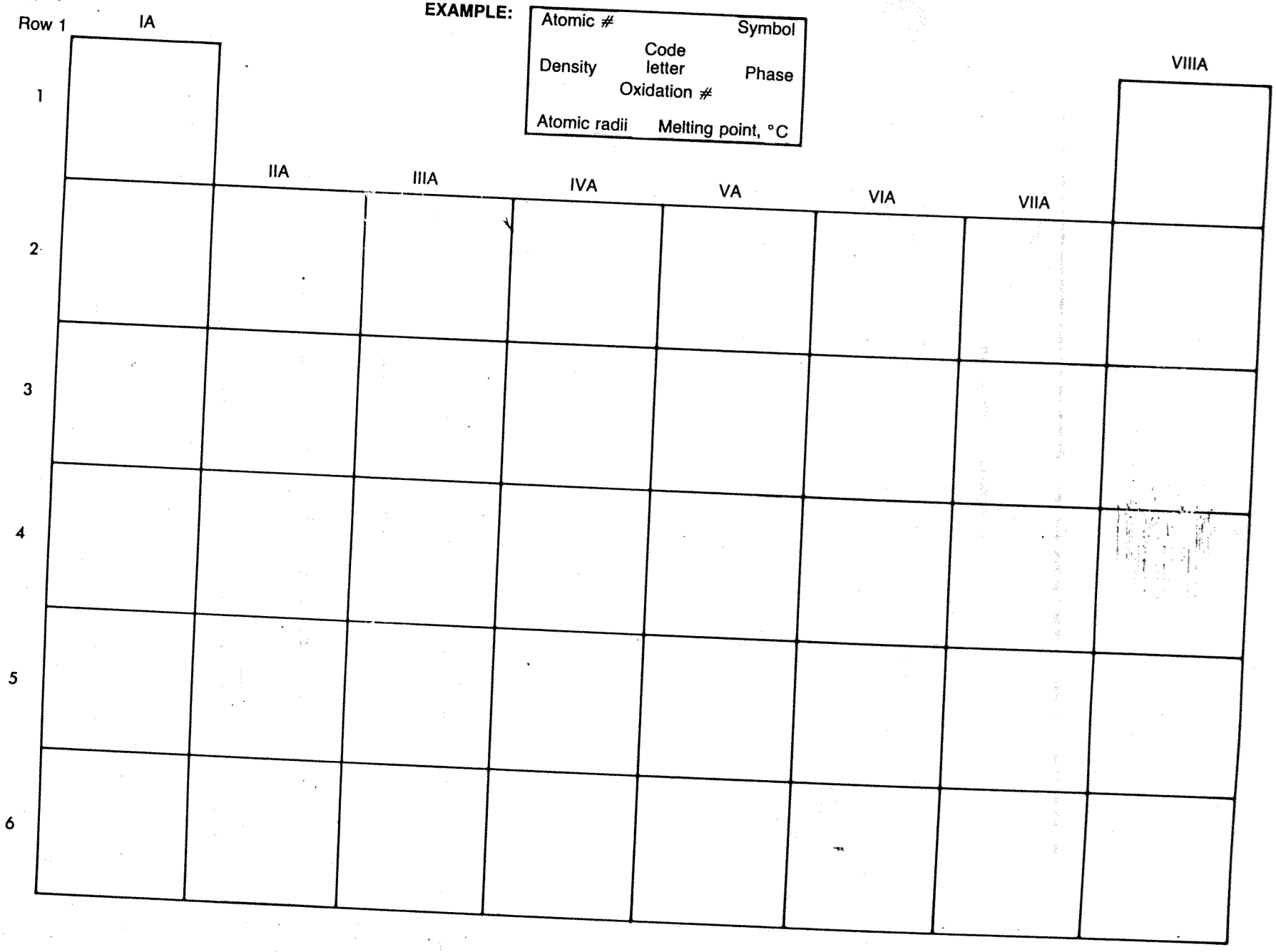
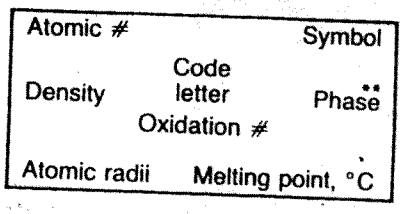

EXAMPLE:
Atomic #
Symbol
Code letter
Density
Phase
Oxidation #
Atomic radii
Melting point, °C
Row 1
IA
IIA
IIIA
IVA
VA
VIA
VIIA
VIIIA
1
2
3
4
5
6

Table 17 - 2

EXAMPLE:



0.0014 A gas 0.066 −218	0.0009 B gas 0.160 −248	1.82 C 0.115 44	5.90 D 0.122 29.8	0.0017 E gas 0.191 −189	0.00009 F gas 0.053 −259	5.32 G 0.123 937	1.85 H 0.111 1278
0.862 I 0.227 64	0.0037 J gas 0.198 −156	4.79 K 0.114 217	1.55 L 0.197 839	0.0013 M gas 0.070 −210	2.33 N 0.117 1410	0.003 O gas 0.099 −101	0.534 P 0.152 180
2.07 Q 0.104 112	2.70 R 0.143 660	0.971 S 0.192 98	1.74 T 0.160 649	2.27 U 0.077 3550	0.0015 V gas 0.072 −219	3.12 W liquid 0.111 −7	0.00017 X gas 0.122 −272
5.7 Y 0.125 817	2.34 Z 0.083 2079	1.53 * 1+ 0.248 39	7.31 * 2+, 4+ 0.141 232	6.69 * 3+, 5+ 0.136 631	0.0059 * 0 0.218 −112	* gas 1− 0.14 302	19.8 * 4+ 6+ 0.157 639
9.75 * 3+, 5+ 0.155 271	1.87 * 0.265 28	6.24 * 4+, 6+, 7+ 450	7.31 * 1+, 3+ 0.163 157	4.93 * 1− 0.128	11.85 * 3+ 0.170 303	0.0097 * gas 0 0.22 −71	3.5 * 2+ 725
11.3 * 2+, 4+ 0.175 328	2.54 * 2+ 0.215 769						

*No code letters **All are solids unless indicated.