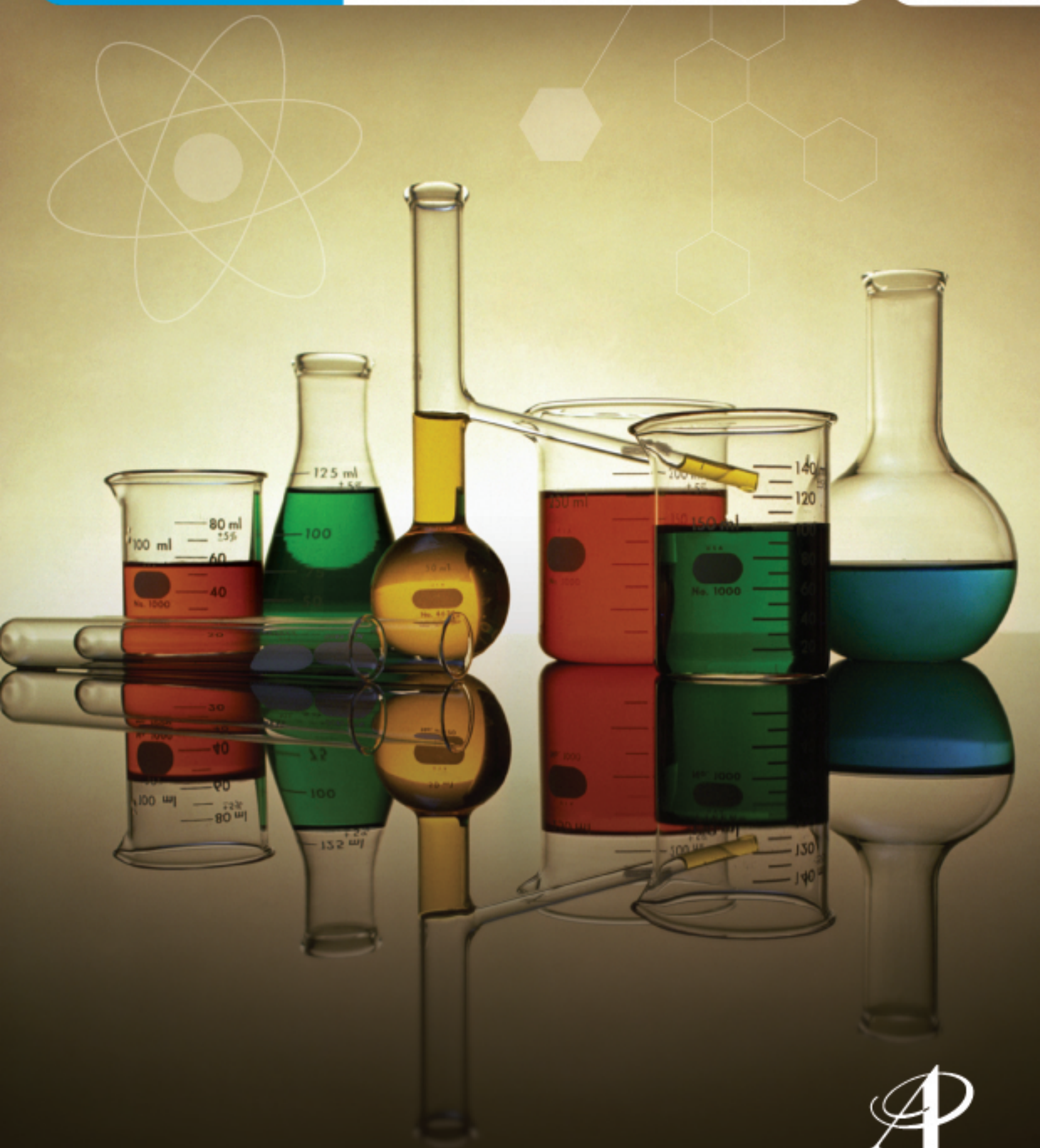
LIFEPAC®

Science



Alpha Omega Publications®

SCIENCE 1105
CHEMICAL FORMULAS, BONDING AND MOLECULAR ARCHITECTURE

CONTENTS

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SCIENCE 1105
CHEMICAL FORMULAS, BONDING AND MOLECULAR ARCHITECTURE

So far you have studied measurement, classification and properties of matter, and atomic structure. All of the ideas and concepts you have learned in chemistry are necessary to understand the chemistry you will study in the rest of this course. The perfect order of our Creator makes His creation predictable. Scientists will never unlock all of the secrets of nature, but some of the regularities and predictions man has learned will be studied in this LIFEPAC®.

OBJECTIVES

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC.

When you have finished this LIFEPAC, you should be able to:

1. Predict chemical formulas by using the Periodic Table.
2. Define and use the concepts of electronegativity.
3. Predict percent ionic and covalent character of bonds.
4. Describe and explain the nature of ionic, covalent, and metallic bonds.
5. Describe and explain the concept of hybridization.
6. Predict molecular shape by knowing the molecular formula.
7. Describe polarity and predict the polarity in molecules.

Survey the LIFEPAC. Ask yourself some questions about this study. Write your questions here.

I. CHEMICAL FORMULAS

How do elements combine? Why do some elements combine in multiple numbers like H_2O, Na_2SO_4, $KMnO_4$, and others combine in one-to-one ratios like NaCl, NaI, CaO, and AgCl? Why is the formula for water H_2O rather than HO or HO_2? Science LIFEPAC 1104 should help give the answers. Have Science LIFEPAC 1104 handy because it will be used often. Also, have the Periodic Table readily available.

SECTION OBJECTIVE

Review this objective. When you have completed this section, you should be able to:

1. Predict chemical formulas by using the Periodic Table.

VOCABULARY

Study this word to enhance your learning success in this section.

ion

Note: All vocabulary words in this LIFEPAC appear in **boldface** print the first time they are used. If you are unsure of the meaning when you are reading, study the definitions given.

ION CHARGE AND COLUMN LOCATION

You may recall from Science LIFEPAC 1104 that the valence electrons are the electrons that determine the chemistry of an atom. Each element of each column had the same valence electron structure as each other element of that column. Because of the similarity among elements of each column, the chemistry of all members of a column (called a *family*) is similar. Therefore, if we know the chemical properties of one member of the family, we know the properties of all members of that family.

Experimental evidence. The following experiment was carried out in a laboratory setting. You will not do it yourself because the chemicals are too expensive. You will be expected to analyze the results, however.

Solutions of sodium chloride, magnesium chloride, and aluminum chloride were made so that each had 0.10 moles of compound per liter of solution.

Do these activities.

1.1 How many moles of each chloride are in one milliliter of the respective solutions?

_____

1.2 Assume that you measured exactly 2.00 ml of the sodium chloride into a small test tube. How many moles of sodium chloride are in the tube? _____

1.3 Consider the situation if your measurements were not exact and you got 0.01 ml too much solution.

a. How many moles extra NaCl would you have? _____

b. What percent error would this excess produce? _____

1.4 Assume you measure out exactly 2.00 ml of magnesium chloride into a second test tube. How many moles of magnesium chloride are in the tube? _____

1.5 Now assume you measure out exactly 2.00 ml of aluminum chloride into a third test tube. How many moles of aluminum chloride are in the tube? _____

A silver nitrate solution that was four times more concentrated than the chloride solutions was added to the chloride. Generally, when silver collides with the chloride they react and form a solid, and a *precipitate* is formed. The 4:1 molar ratio will insure that more silvers than chlorides cause all chlorides to precipitate out. A white precipitate formed in each test tube, and the test tubes were let stand about five minutes. The height of the precipitate in the test tube was measured and recorded. Using the height of the precipitate in the sodium chloride test tube as a standard equal to 1, the magnesium chloride precipitate was two times as high. Again with the sodium chloride as the standard of 1, the aluminum chloride precipitate was three times as high. Silver chloride was the precipitate in each reaction.

Do these activities.

1.6 The mole ratio of silver chloride produced in each case using sodium chloride as the reference was 1: _____ : _____

1.7 In this experiment what is the whole-number mole ratio of sodium chloride to magnesium chloride to aluminum chloride? _____ : _____ : _____

1.8 Using the whole number ratio in 1.7 and the ratio for AgCl produced and calculated in 1.6, complete balancing the equations for three reactions.

a. _____ $NaCl$ + _____ $AgNO_3$ $\longrightarrow$ _____ $AgCl$ + _____ $NaNO_3$

b. _____ $MgCl_2$ + _____ $AgNO_3$ $\longrightarrow$ _____ $AgCl$ + _____ $Mg(NO_3)_2$

c. _____ $AlCl_3$ + _____ $AgNO_3$ $\longrightarrow$ _____ $AgCl$ + _____ $Al(NO_3)_3$

1.9 For some reason one sodium atom combines with one chlorine atom ($NaCl$), one magnesium combines with two chlorine atoms ($MgCl_2$), and one aluminum atom combines with three chlorine atoms ($AlCl_3$). In Science LIFEPAC 1104 you learned that valence electron structure was the key to the chemistry of the various atoms. Why do the three metals each combine differently with chlorine? (Review Science LIFEPAC 1104).

ELEMENT	Na	Mg	Al	Cl	INERT GAS
Family Member	IA	a.	b.	c.	d.
Valence e- Number	e.	2	f.	g.	h.
Family Valence e- Number	i.	j.	k.	7	l.

1.10 Answer these questions about the previous chart.

a. What is the most stable family of elements? _____

b. How many valence electrons does this family have? _____

c. What is true about the *s* and *p* sublevels of each member? _____

_____

Valence electron charge. Nearly all atoms tend to gain or lose valence electrons in a chemical reaction to take on the inert gas structure and have complete *s* — *p* sublevels. Whether a family of elements gains or loses depends upon which is easier. For example, less energy is required for sodium to lose its one valence electron and take on the electron structure of Ne than to gain seven electrons to have the structure of Ar.

Do these activities.

1.11 How would Mg change to gain an inert gas structure?

_____

_____

1.12 How would Al change to gain stability?

_____

_____

1.13 How could Cl change to gain stability?

_____

_____

Adult check _____
Initial Date

FORMULA PREDICTION

When the sodium atom, magnesium atom, aluminum atom, and chlorine atom change their outer electron shells to a more stable configuration, they become **ions**. This change means that they have gained or lost electrons and now have an unequal number of electrons (-) and protons (+). Since in a chemical reaction the atomic number [number of protons (+)] *always* remains the same, a gain or loss of electrons will result in the particle having a net electrical charge. An example might be lithium. A lithium atom enters a chemical reaction with three electrons and three protons, but generally loses one electron. This loss means that lithium has a net charge of +1, meaning one excess positive charge or one more proton than electron.

Before: 3+ and 3- = net charge of 0
After: 3+ and 2- = net charge of +1 (lost one electron)

Complete the following table using the ideas from the previous paragraph.

	Elements	Electron Structure of Atom	Electron Structure of Ion	Net Ion Charge
	Lithium	**$1s^2\ 2s^1$**	**$1s^2$**	**1+**
1.14	**Beryllium**	**a.**	**b.**	**c.**
1.15	**Chlorine**	**a.**	**b.**	**c.**
1.16	**Sodium**	**a.**	**b.**	**c.**
1.17	**Fluorine**	**a.**	**b.**	**c.**
1.18	**Oxygen**	**a.**	**b.**	**c.**
1.19	**Magnesium**	**a.**	**b.**	**c.**
1.20	**Calcium**	**a.**	**b.**	**c.**
1.21	**Boron**	**a.**	**b.**	**c.**
1.22	**Phosphorous**	**a.**	**b.**	**c.**
1.23	**Sulfur**	**a.**	**b.**	**c.**
1.24	**Aluminum**	**a.**	**b.**	**c.**
1.25	**Nitrogen**	**a.**	**b.**	**c.**
1.26	**Silicon**	**a.**	**b.**	**c.**
1.27	**Carbon**	**a.**	**b.**	**c.**