AIM 5 | How do some compounds form?

You have learned about electron shells. Now use this knowledge to understand how atoms link up to form compounds.

Not all atoms form compounds. Only atoms that have outer shells that are *not* full form compounds.

The elements of Group O have complete outer shells. These atoms do *not* form compounds. All other atoms have outer shells that are not full. All other atoms form compounds.

Atoms form compounds by combining their outer-ring electrons. A total of 8 outer-ring electrons is needed.

Here's an example. An atom with 7 outer-ring electrons will form a compound with an atom with 1 outer-ring electron. (7 + 1 = 8.) (See Figure C.)

An atom with 6 outer-ring electrons will link up with an atom with 2 outer-ring electrons. (6 + 2 = 8.)

In Aim 4 you learned that:

- Atoms of *metals* have *fewer* than 4 outer-ring electrons.
- Atoms of *nonmetals* have *more* than 4 outer-ring electrons.

When forming a compound:

- The metal transfers or "lends" outer-ring electrons to the nonmetal.
- The nonmetal "borrows" these electrons.

Here is an easy way to remember this:

M
E
T
A
LEND > ELECTRONS
S

If metals lend electrons, then nonmetals borrow them. A compound has at least one metal and one nonmetal.

UNDERSTANDING HOW A COMPOUND FORMS

Sodium (Na) and chlorine (Cl) link up to form the compound sodium chloride (NaCl)—common table salt. Let's see how it happens.

First, let's look at the *atoms* of sodium and chlorine.

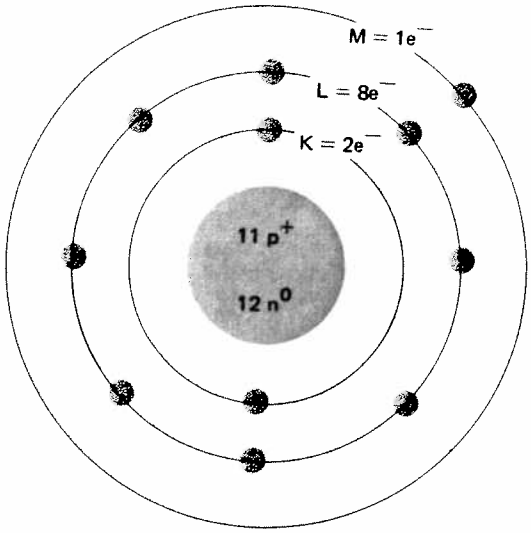

Figure A
A sodium atom

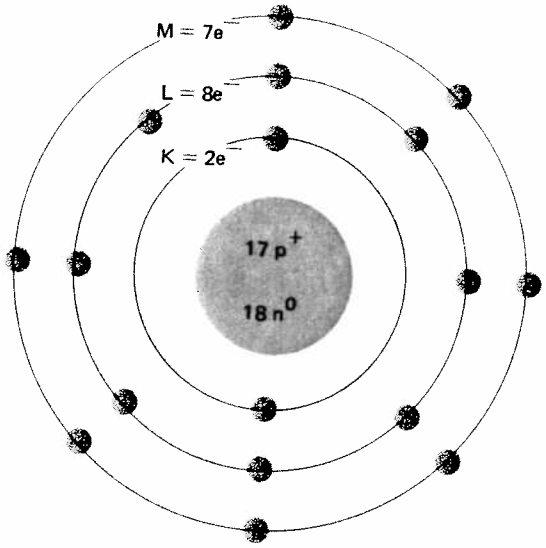

Figure B
A chlorine atom

1. How many protons does a sodium atom have? _____
2. How many electrons? _____
3. Is the number of protons the same as the number of electrons? _____
4. Is a sodium atom neutral? _____
5. How many outer-ring electrons does sodium have? _____
6. Is its outer ring full? _____
7. Is sodium a metal or a nonmetal? _____

8. How many protons does a chlorine atom have? _____
9. How many electrons? _____
10. Is the number of protons the same as the number of electrons? _____
11. Is a chlorine atom neutral? _____
12. How many outer-ring electrons does chlorine have? _____
13. Is its outer ring full? _____
14. Is chlorine a metal or a nonmetal? _____

15. Which atom will be an electron lender? _____

16. Which atom will be an electron borrower? _____

17. Add up your answers to questions 5 and 12. _____

Is that the same number of electrons that make up a full shell? _____

THE CHEMICAL REACTION

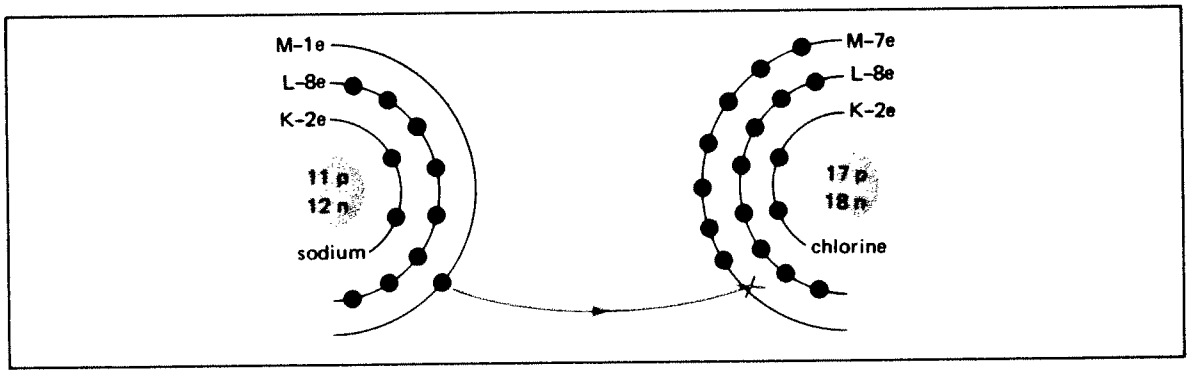

Figure C

1. How many electrons does sodium lose to chlorine? _____

2. Sodium now has _____ electrons and _____ protons.

3. Does sodium still have an equal number of electrons and protons? _____

4. How many electrons does chlorine borrow? _____

5. Chlorine now has _____ electrons and _____ protons.

6. Does chlorine still have an equal number of electrons and protons? _____

Why do sodium and chlorine combine?

When sodium and chlorine combine, sodium LOSES an electron. The chlorine GAINS an electron.

Are sodium and chlorine still neutral atoms? NO! Now, they each have a *charge.*

The neutral sodium atom lost 1 electron. Therefore, it now has 11 positive charges and only 10 negative charges—or 1 extra positive charge.

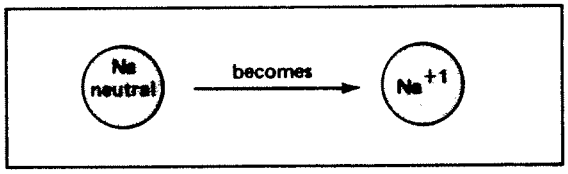

Figure D

Chlorine now has 1 extra negative charge.

We know that atoms are *neutral*. Sodium and chlorine are no longer neutral. So they are no longer atoms. They have charges. We call an atom with a charge an ION [EYE on].

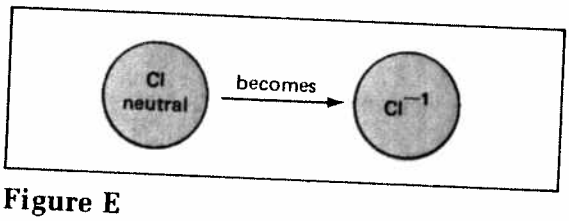

Figure E

Sodium is a *positive* ion because its charge is +1.

Chlorine is a *negative* ion because its charge is −1.

Opposite charges attract. Positive and negative ions are attracted to one another.

The opposite charges hold the sodium and chlorine ions together. Together they form *sodium chloride*. Sodium chloride is a compound.

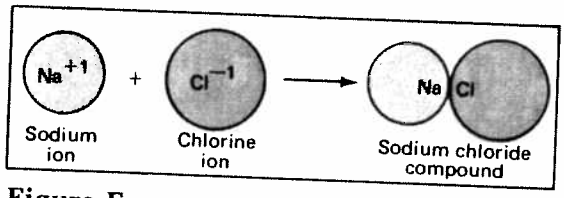

Figure F

LET'S TRY ANOTHER EXAMPLE

Look at Figure G. It shows how one magnesium atom combines with two fluorine atoms.

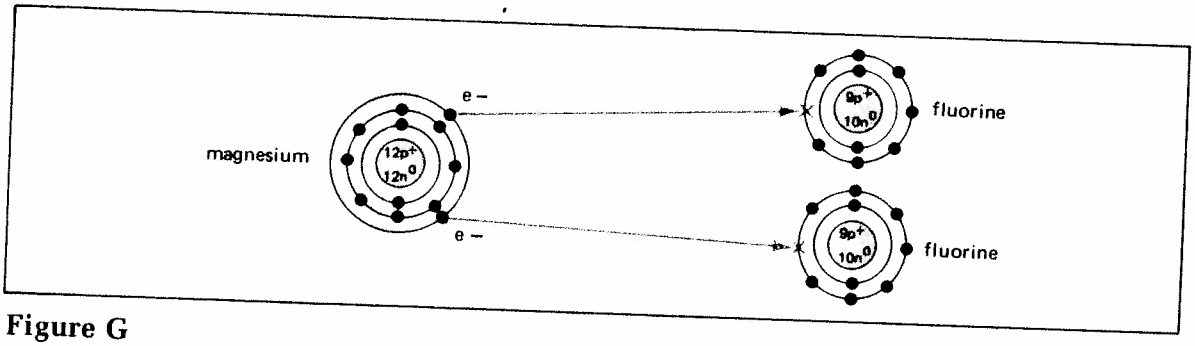

Figure G

1. How many electrons does magnesium lose? _____
2. How many minus charges does magnesium *lose*? _____
3. How many minus charges does magnesium now have? _____
4. How many plus charges does magnesium now have? _____
5. The magnesium now has a _____ charge.
   (+2, −2)
6. What do we call a charged atom? _____
7. The magnesium is a _____ ion.
   (positive, negative)
8. How many electrons does *each* fluorine atom gain? _____

9. How many minus charges does *each* fluorine atom gain? _____

10. How many *minus* charges does each fluorine atom now have? _____

11. How many *plus* charges does each fluorine atom now have? _____

12. What charge does each fluorine atom now have? _____ (+1, −1)

13. The fluorine is now a _____ (positive, negative) ion.

14. The magnesium and fluorine ions have _____ (opposite, the same) charges.

15. They _____ (do, do not) attract one another.

16. The compound that magnesium and fluorine form is magnesium fluoride. What *keeps* the magnesium fluoride together? _____

WRITING SYMBOLS FOR IONS

■ An *atom* has no charge. It is shown as a symbol followed by a small zero. For example, this is the symbol for a chlorine atom Cl^0.

■ An *ion* is shown as a symbol followed by the charge value. For example, this is the symbol for a chlorine *ion* Cl^{-1}.

Use what you have learned about atoms and ions. Complete the information below. The first line has been done for you.

	ATOMS		IONS
1.	Ca^0 − ***2*** electrons	⟶	Ca^{+2}
2.	O^0 + _____ electrons	⟶	O^{-2}
3.	K^0 _____ electrons	⟶	K^{+1}
4.	Ag^0 _____ electrons	⟶	Ag^{+1}
5.	F^0 _____ electrons	⟶	F^{-1}

NOW LET'S TRY IT ANOTHER WAY.

Again, the first line has been done for you.

	ATOMS		IONS
6.	Al^0 − 3 electrons	⟶	***Al^{+3}***

7. P^0 +3 electrons ⟶ _____

8. Li^0 −1 electron ⟶ _____

9. Be^0 −2 electrons ⟶ _____

10. I^0 +1 electron ⟶ _____

COMPLETING CHARTS Several elements are listed below. Find them in the Periodic Table (pages 168–169). Then fill in the empty spaces.

The first element, copper, has already been done for you.

	Element	Number of Electrons in Outer Ring	Metal or Nonmetal?	Lends or Borrows Electrons?	Can Lend or Borrow How Many Electrons?
1.	Copper	*1*	***metal***	***lends***	*1*
2.	Phosphorus				
3.	Iodine				
4.	Vanadium				
5.	Cobalt				
6.	Sodium				
7.	Nitrogen				
8.	Helium				
9.	Gold				
10.	Zinc				

MATCHING Match the two lists. Write the correct letter on the line next to each number.

1. _____ compound
2. _____ at least one metal and one nonmetal
3. _____ 8
4. _____ metals
5. _____ nonmetals

a) needed to form a compound

b) borrow electrons

c) two or more linked-up atoms

d) total number of outer-ring electrons needed to form a compound

e) lend electrons

KEEPING UP WITH SCIENCE

IONS AND HOW YOU FEEL

Have you ever heard of Witches' Winds? They sweep across several parts of the earth and are known by different names in the places where they blow. They are called *Santa Ana* in Southern California, *Chinook* in Canada, *Foem* in Central Europe, and *Sharov* in Israel.

There is some evidence of an increase in illness, family quarrels, accidents, suicides, and even murder when these winds arrive. Are these unfortunate events and Witches' Winds somehow related? Here is a theory.

Air consists of molecules of gases. The molecules are electrically *neutral*. That is, they contain an equal number of positive and negative charges.

Air also contains *ions*. Ions are atoms or molecules that *do* have an electrical charge. An ion may have a positive or a negative charge. Atoms are turned into ions by certain radiations, electricity, and the friction of moving water, sand, snow or hail.

Sometimes, the number of ions in the air increases greatly. Several scientists believe that large quantities of air ions influence personality and behavior.

It is a fact, that Witches' Winds bring a large number of *positive ions*. Positive ions, it is believed, can make some people tense, irritable, and moody. If this is true, then Witches' Winds may indeed play a role in causing damaging behavior and ill health.

Negative ions, it is believed, can have an *opposite* effect. Negative ions may make some people *less* tense, *more* relaxed, and happy. Negative ions seem to make people healthier.

There are many negative ions around waterfalls. People generally feel relaxed around waterfalls. Is there a connection between this feeling and negative ions? Possibly.

Experiments have been carried out in *high-positive* and *high-negative* ion environments. The findings indicate that there *is* a link between air ions and health and behavior. The findings, however, are uncertain. Much more testing is needed to change this theory to scientific fact.

Some manufacturers have produced negative-ion generators. The negative ions they produce are supposed to stop the bad effects of positive ions. The U.S. Food and Drug Administration had these devices taken off the market. The FDA could find no proof that they are really doing what they claim.