



What Makes Us Stick Together?

Student Activity

Name _____

Class _____

Open the TI-Nspire document

What_Makes_Us_Stick_Together.tns

Why will a solution of table salt conduct electricity, but a solution of table sugar will not? Even though table sugar ($C_{12}H_{22}O_{11}$) and ethyl alcohol (C_2H_5OH) are made of the same three elements, why are their properties so different? Why are covalent compounds made up of nonmetals? These and other interesting questions will be answered in this simulation.



Covalent compounds are made up of nonmetal elements that share electrons. Because of their relatively high electronegativity, nonmetals tend to share electrons rather than transfer them as metals do. These elements share electrons in order to reach a stable octet—an electron configuration in which atoms have eight electrons in their outer shell. The outer shell electrons that can be shared are called valence electrons.

When nonmetals share electrons to form covalent compounds, molecules form. Since molecules are stable and do not readily give up their shared electrons, they do not readily conduct electricity. The molecules themselves are neutral, so a flow of molecules does not produce an electric current. Polar molecules in water solution may ionize and conduct electricity. An example would be HCl, which is a polar covalent molecule. When dissolved in water, it forms ions and conducts. When metals and nonmetal atoms transfer electrons, they form ionic compounds composed of oppositely charged ions that are held together by strong electromagnetic forces. Since ions are charged, ionic compounds can conduct electricity if the ions are free to move (when the compound is dissolved or when it is heated until molten).

Electronegativity is a measure of the tendency of an atom in a compound to attract electrons to itself. Because of their relatively high electronegativity, nonmetals bonding with nonmetals tend to share electrons rather than transferring them, as they do when bonding with metals. The most electronegative element in a chemical compound is assigned a negative oxidation state. The most electropositive element is assigned a positive oxidation state. For methane, CH_4 , the carbon is given a -4 oxidation state. The hydrogen is given a $+1$ oxidation state. The sum of the oxidation states for the atoms in a covalent compound must total zero. Therefore, it takes four hydrogen, (four times $+1$), to balance out the -4 oxidation state of the carbon.

Polyatomic ions such as sulfate (SO_4^{2-}) are also bonded together covalently. In this case, the sum of the oxidation states must equal the charge of the ion. Therefore, sulfur is $+6$ and oxygen is four times -2 to total to the sulfate ion charge of $2-$.



Move to pages 1.2–1.6.


Press **ctrl** ► and **ctrl** ◀ to navigate through the lesson.

Answer questions 1–5 here and/or in the .tns file.

- Q1. Covalent compounds are made up of two or more _____.
- A. metals
B. metalloids
C. nonmetals
D. all of the above
- Q2. Covalent compounds reach stability by acquiring _____ in their outer electron shell.
- A. a duet
B. a trio
C. a quartet
D. an octet
- Q3. Electrons in the outer shell of an atom are called _____ electrons.
- A. nuclear
B. valence
C. transfer
D. atomic
- Q4. The measure of the tendency to attract electrons to an atom is called _____.
- A. conductivity
B. electronegativity
C. ductility
D. malleability
- Q5. The oxidation states of all atoms in a covalent compound must total to _____.
- A. -4
B. -2
C. 0
D. +4

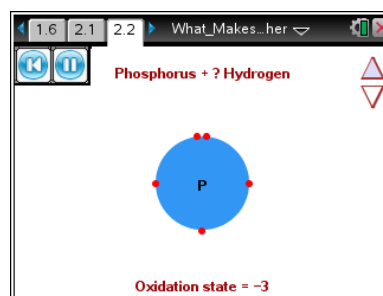
Move to pages 2.1–2.2.

Explore covalent bonds between two nonmetals on page 2.2.

1. Press **esc** or the reset button  for a new question. Two random elements will be chosen.
2. The number of bonded atoms can be increased and decreased using the up and down arrows on the right side of the screen or press a number, **1**, **2**, **3**, or **4**.

Remember that most elements, except for hydrogen and helium, need to share electrons to reach a stable octet of valence electrons. Hydrogen and helium are stable with a duet of valence electrons.

3. **Be sure to note the changes to the oxidation state shown at the bottom of the screen.** Look for patterns between the model and the equation above and below the model, in red, as you increase and decrease the number of bonded atoms. Use the space on the next page to record your observations.







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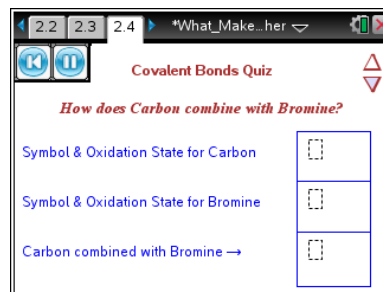
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Move to pages 2.3 and 2.4.

4. Read the instructions for the Covalent Bonds Quiz on page 2.3. To check your answer press . To go to the next question press .
5. On page 2.4, work through the quiz until you get five correct compounds. Record the compounds in the space below.



Suggestion: Record the oxidation states of the elements for later reference!

Move to pages 3.1–3.10. Answer questions 6–15 here and/or in the .tns file.

- Q6. When carbon and chlorine combine to make carbon tetrachloride, CCl_4 , a total of eight electrons are _____.
- A. gained
B. lost
C. shared
D. created
- Q7. When hydrogen chloride gas (HCl) is formed, each atom shares _____ electron(s).
- A. one
B. two
C. three
D. four
- Q8. When hydrogen and sulfur react to make a covalent compound, _____ hydrogen atom(s) will combine with _____ sulfur atom(s).
- A. one, one
B. one, two
C. two, one
D. two, two
- Q9. When nitrogen and hydrogen react to make ammonia, _____ hydrogen atom(s) will combine with _____ nitrogen atom(s).
- A. one, one
B. one, three
C. three, one
D. three, three



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- Q10. For the compound SCl_2 , the sulfur will share _____ electron(s) with each chlorine atom.
- A. one
B. two
C. three
D. four
- Q11. For the compound SCl_2 , how many total electrons will be shared between the sulfur and chlorine?
- A. one
B. two
C. three
D. four
- Q12. For the compound SCl_2 , the sulfur will be _____ and the chlorine will be _____.
- A. electropositive, electropositive
B. electronegative, electronegative
C. electronegative, electropositive
D. electropositive, electronegative
- Q13. Why will a solution of table salt conduct electricity, but a table sugar solution will not?
- Q14. Even though sugar and ethyl alcohol are made of the same three elements, why are their properties so different? (Reread the discussion section at the beginning of the activity.)
- Q15. Why are covalent compounds made up of nonmetals?