# Types of Bonds

Teacher's Guide

## 1.0 Summary

The "Types of Bonds" activity is the fifth activity in the Chemica sequence. This activity should take students approximately 20 minutes to complete.

## 2.0 Learning Goals

**Driving Question:** What are the different types of bonds in an atom?

This activity provides an overview of covalent, polar covalent and ionic bonds. Students will learn about how electronegativity affects electron distribution in chemical bonds. They will also explore electronegativity on the periodic table.

### Learning Goals

- Students will review how to recognize different graphical representations of chemical bonds.
- Students will understand that electrons in bonds are not evenly distributed.
- Students will understand how electronegativity affects chemical bonds.
- Students will be able to classify bonds as covalent, polar covalent, or ionic.
- Students will be able to predict the effects of polarity on macroscopic properties.

### Additional Teacher Background

Bonds that form between atoms are usually more stable than un-bonded atoms. Thus these bonds form to reduce the potential energy of atoms. These bonds form when negatively charged electron clouds can be shared between two different positively charged nuclei. Each atomic nucleus has its own attraction for additional electrons. This attraction is dependent upon the number of protons in the nucleus, the number of its electrons, and the distance of these electrons from the nucleus. This attraction is called electronegativity. This is a unit-less number that simply compares the pull of different nuclei for electrons: the higher the number, the stronger the pull.

Comparing electronegativity between different atoms allows us to classify bonds. When the difference is greater than 1.8 we say that the bonds are ionic. When the difference is between 0.7 and 1.8 we say that the bonds are polar covalent or polar. When the difference is less than 0.7 we say that the bonds are covalent. It is worth noting that these divisions are somewhat arbitrary and help us to classify the bonds. The difference in electronegativity represents a continuum and the classification values are not unchangeable.

## 3.0 Standards Alignment

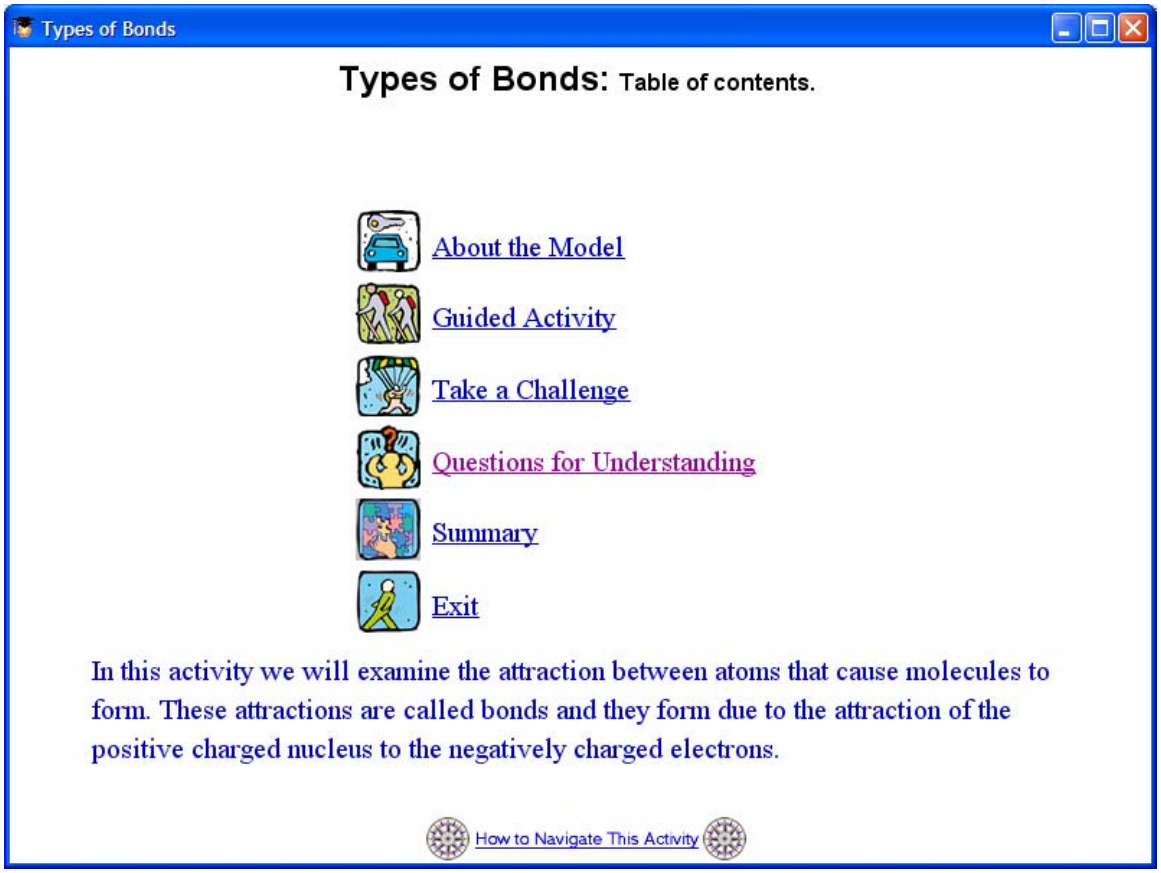
### Alignment to National Math and Science Standards (NCTM or NSES)

| Objective | Standards |
|---|---|
| **Students will understand how to classify different types of bonds.** | • Varies by state. |
| **Students will understand what holds atoms together.** | • Varies by state. |
| **Students will be able to link bond type to macroscopic properties.** | • Varies by state. |

# 4.0 Activity Sections

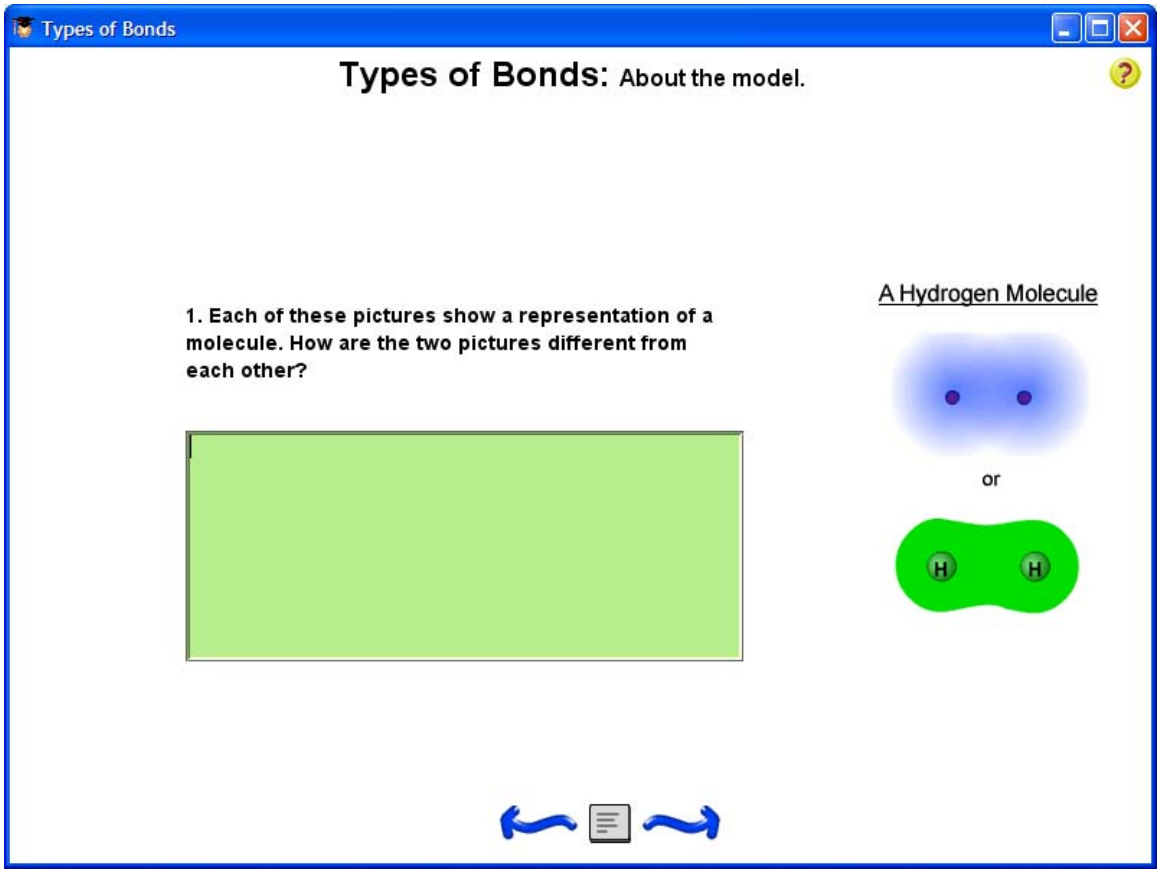
## 4.1 Table of Contents

This activity has 5 sections.



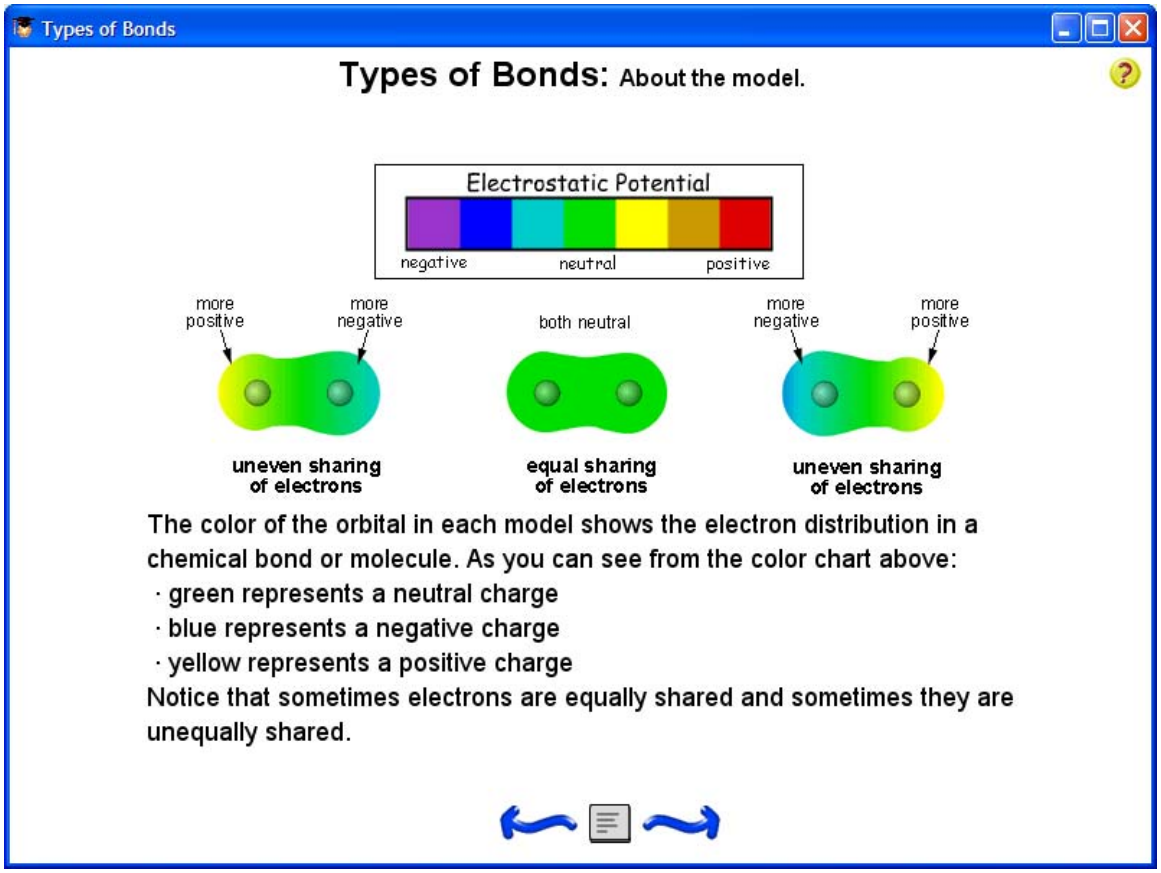

## 4.2 About the model

In this step students are first asked to review different views of bonded atoms. The students are then asked to compare these different views:




It is worth noting the different colors and the difference in shading between the two models. The shading represents the different electron densities around the nucleus.

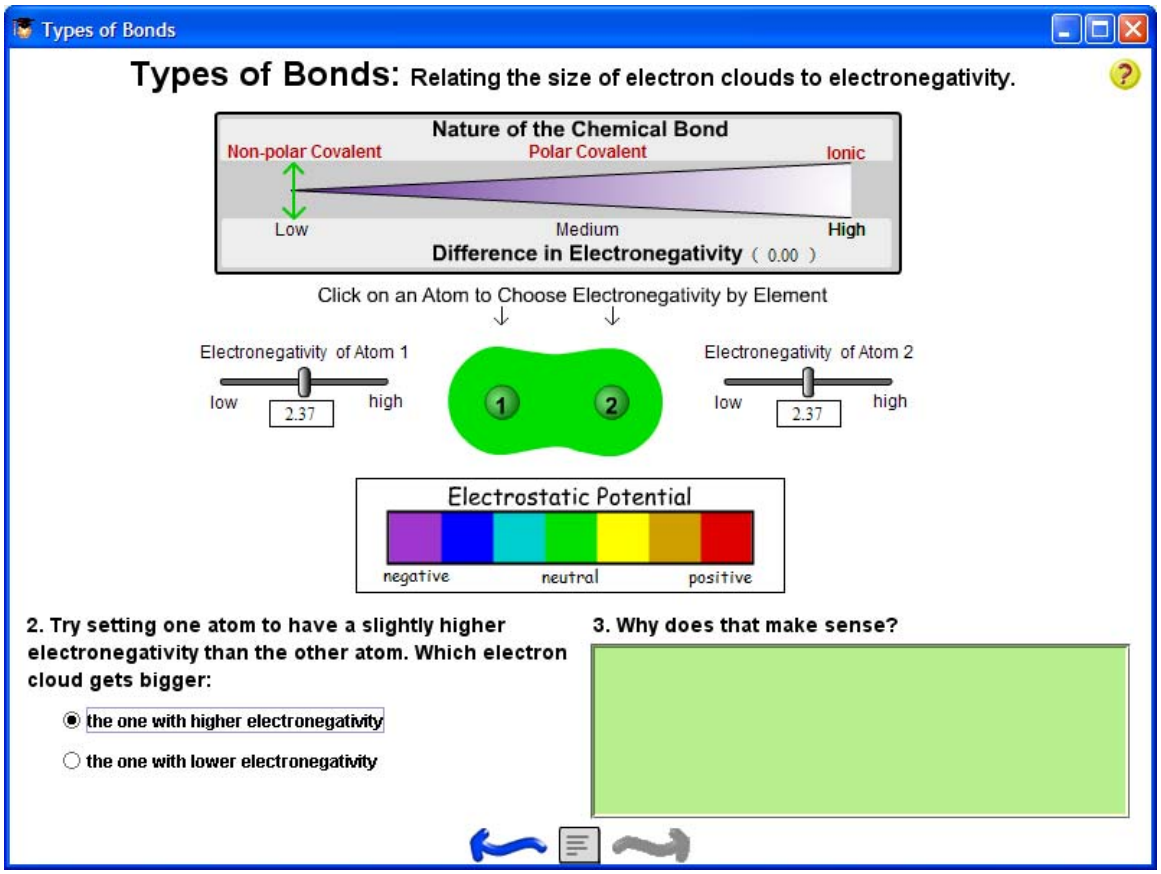
This section then goes on to show another way of viewing bonding electrons:




This model is designed to show students that electrons do not evenly surround bonded atoms. This uneven electron distribution causes an uneven charge. The distribution is affected by the nuclear attraction for electrons. The attraction is measured by electronegativity.

## 4.3 Guided activity

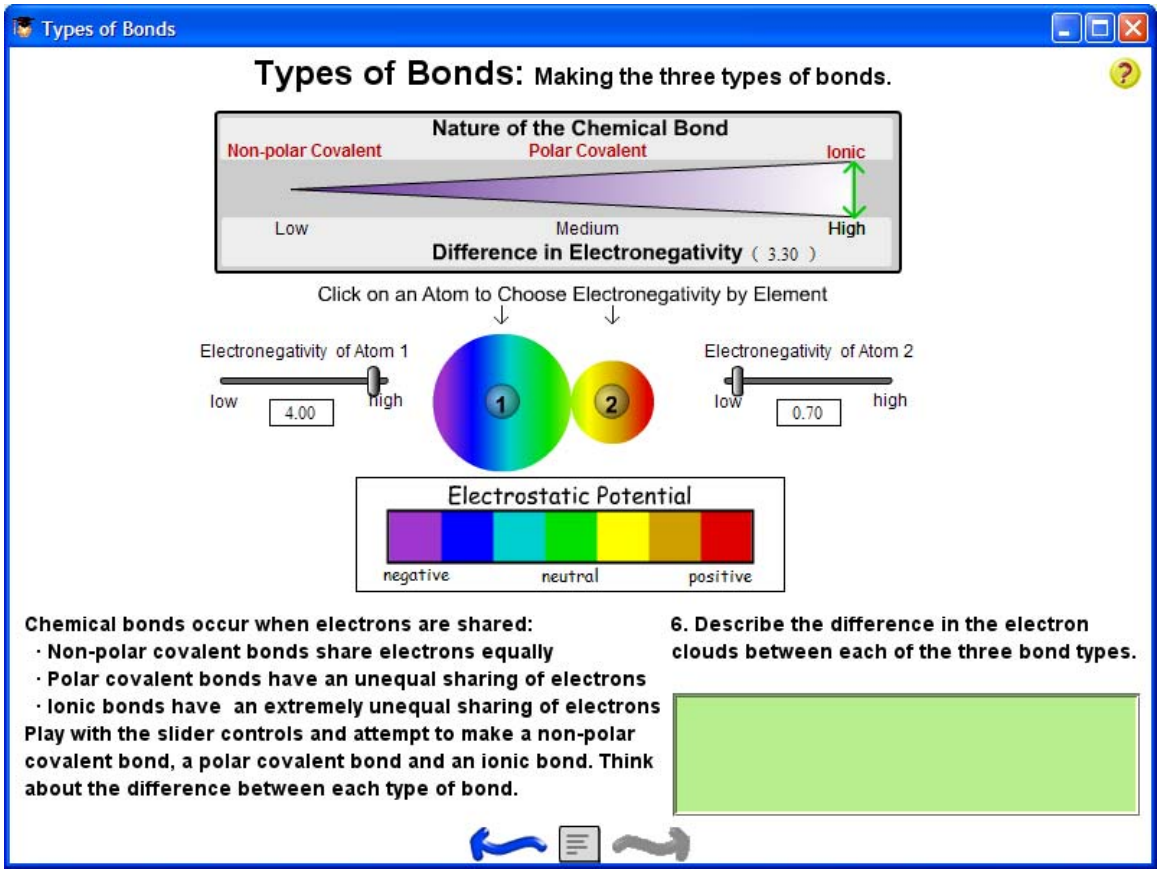
This section introduces the student to the model that allows the formation of different types of bonds by changing electronegativity:




In the model students vary electronegativity of two different bonding atoms and observe the effects. It is worth noting that the side with higher EN is more negative and has a larger cloud.

In the next section students must play with the sliders to make:

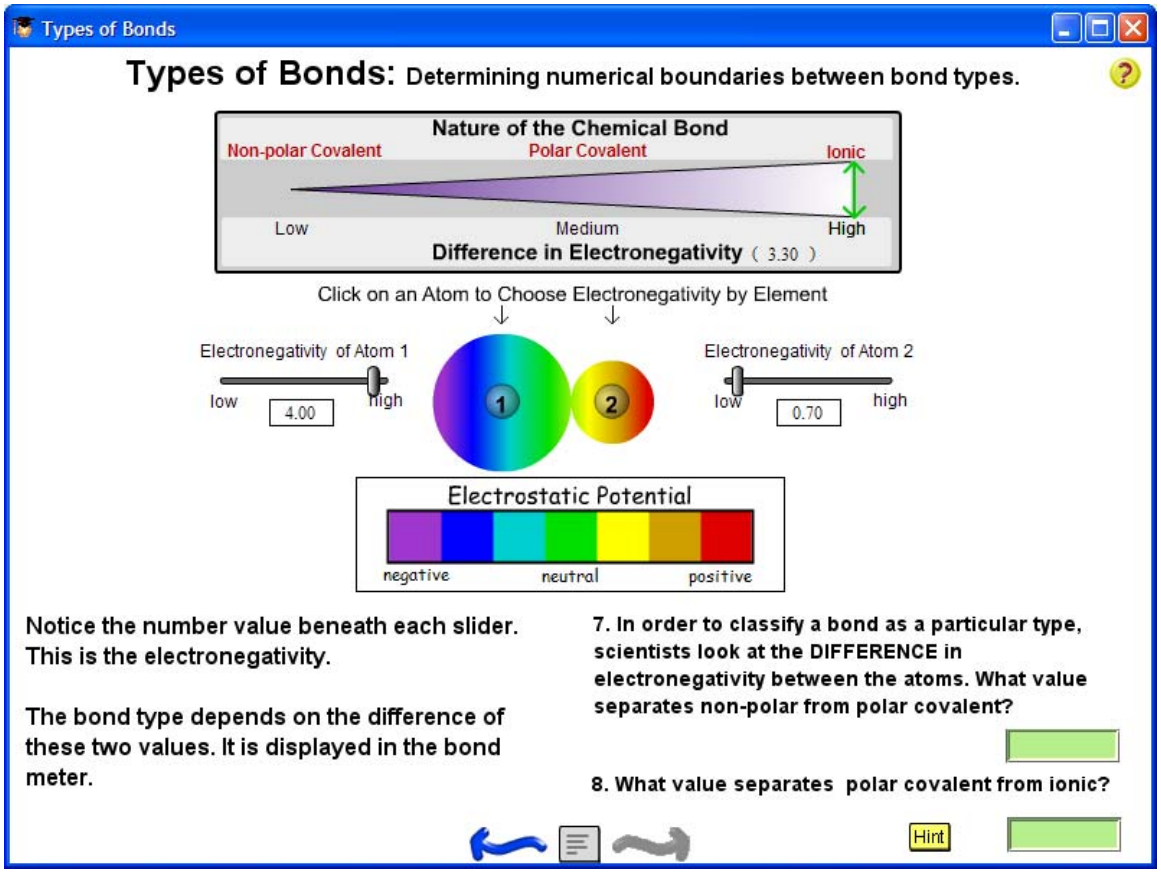
- A covalent bond (equal EN)
- A polar bond (EN between 0.8 and 1.7)
- An ionic bond (EN greater than 1.7)




This screen will not allow the students to move on until they have made the three different types of bonds. To create the bonds, they must move the sliders to adjust the electronegativity of Atom 1 and Atom 2.

After the students have made all three different types of bonds, question 6 will appear. Students should then describe the differences in size, electron distribution (or uneven distribution) and charge on each side of the atom.

On the following screen, students are encouraged to numerically distinguish between the different types of bonds: covalent, polar and ionic.

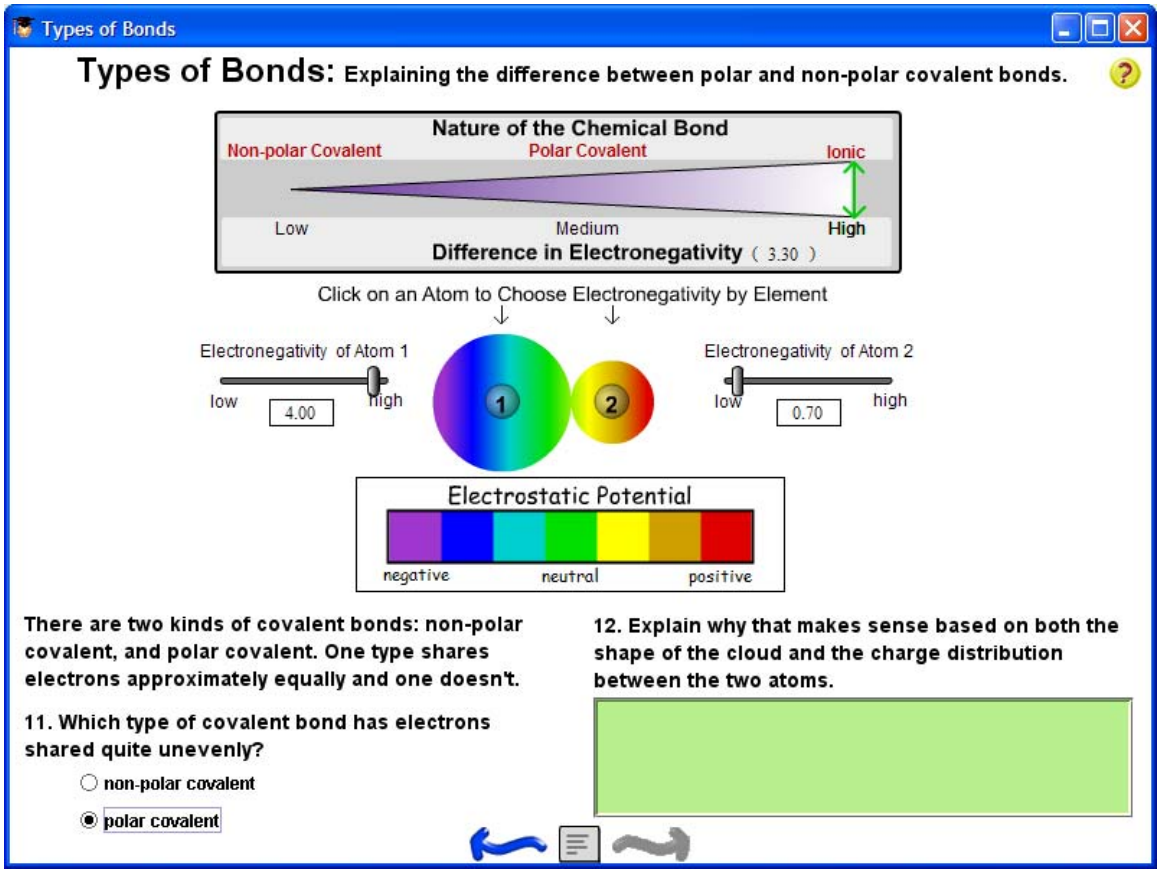



Check hints for help!

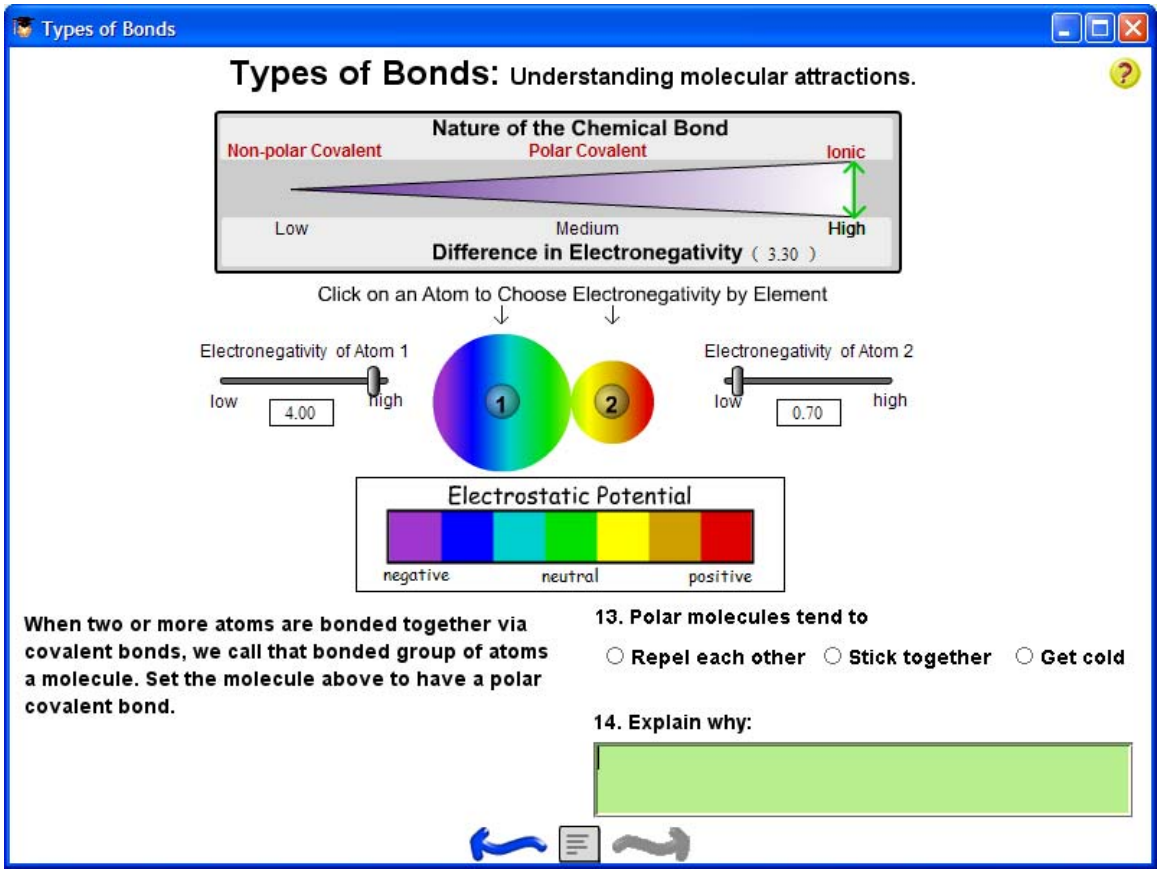
It is important for students to experiment with the model so that they can determine these numbers on their own. The difference between non-polar (covalent) and polar is about 0.8. The difference between polar and ionic is about 1.7. The program will take a range of numbers.

The following screen focuses on covalent bonds. The student can make covalent bonds by setting similar EN's for each atom. This means that both EN's can be high, medium or low. Note that polar bonds are those bonds that have a charge.

On the next screen students examine polar covalent bonds. These bonds have uneven electron distribution as well as a larger negative electron cloud and a smaller, less negative electron cloud.




On the last screen of this section:

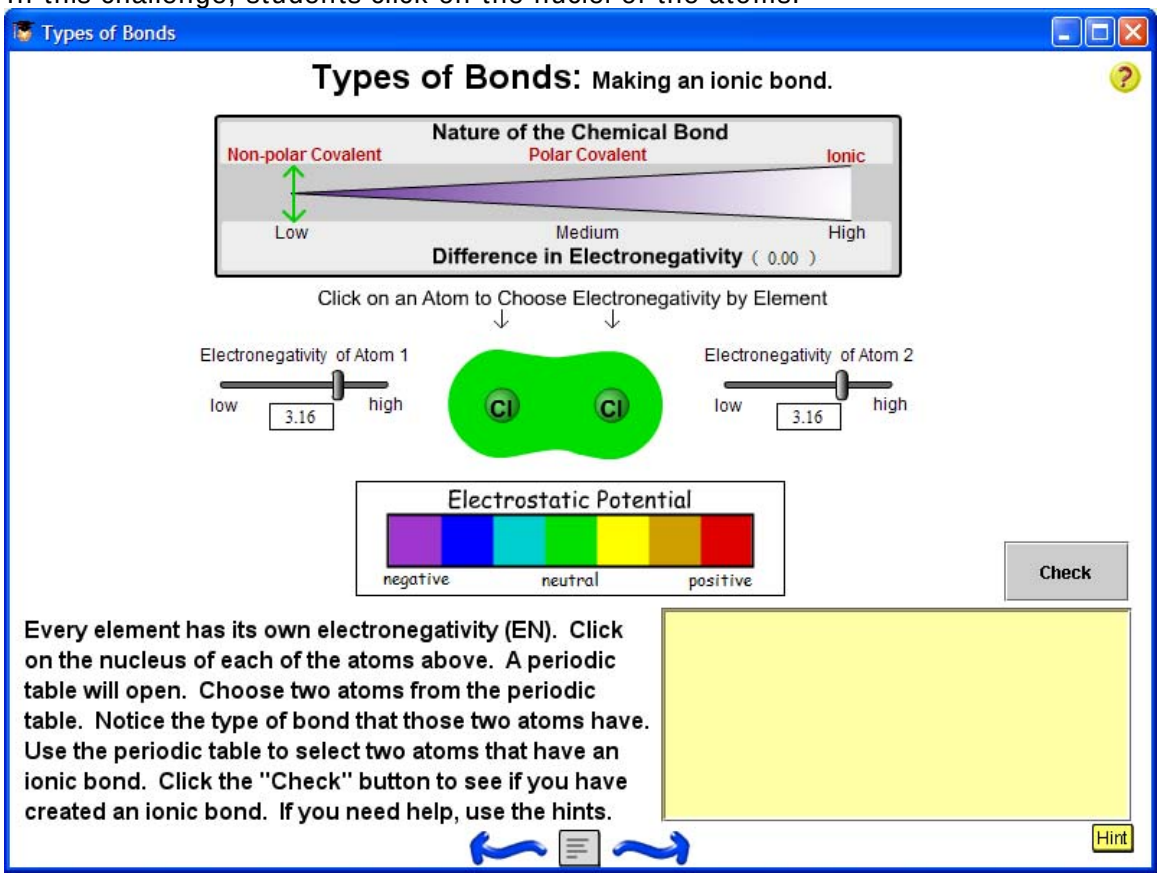


Students construct a polar bond and are asked to consider the implications of these bonds. Since polar molecules have both a positive and a negative side these molecules tend to stick together.

## 4.4 Take a challenge

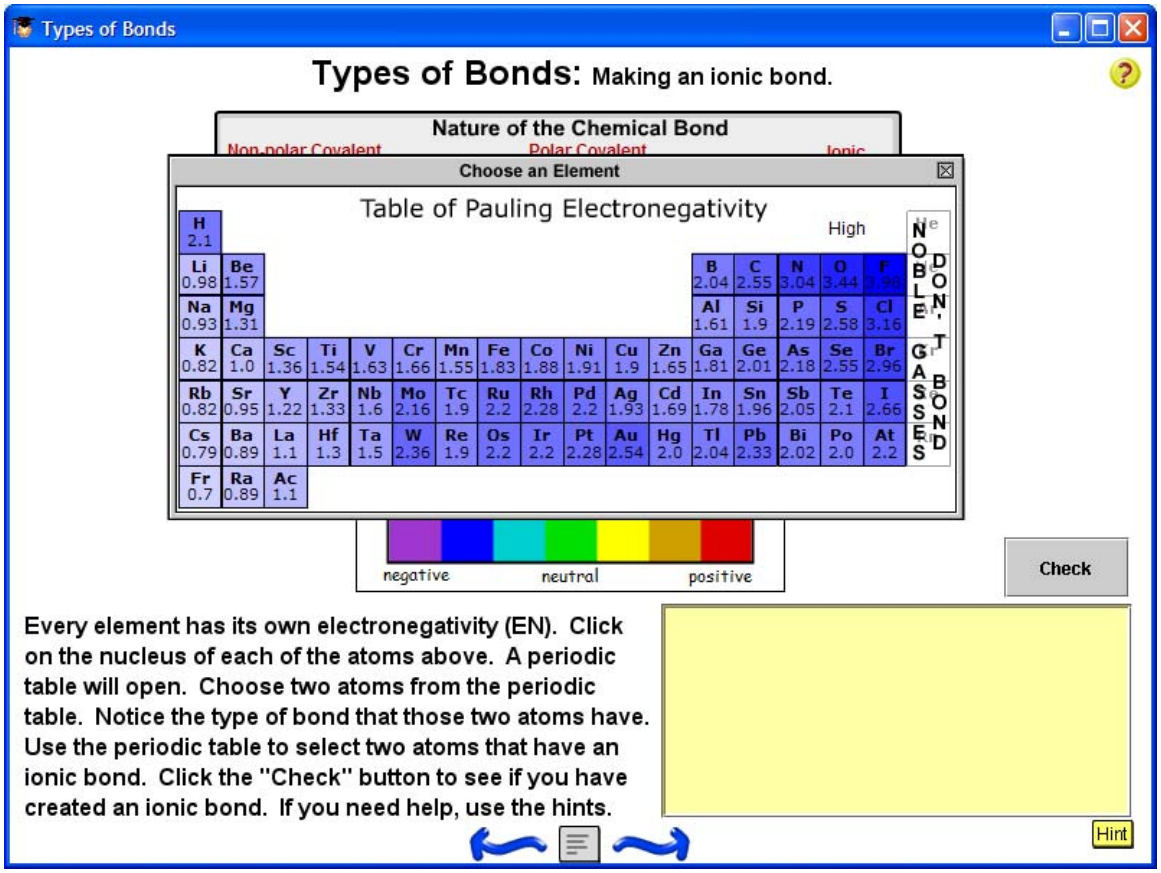
In this section, students model ionic and covalent bonds. Ionic bonds come from opposite sides of the periodic table while covalent bonds occur between molecules that are both on the right side of the table.

In this challenge, students click on the nuclei of the atoms.



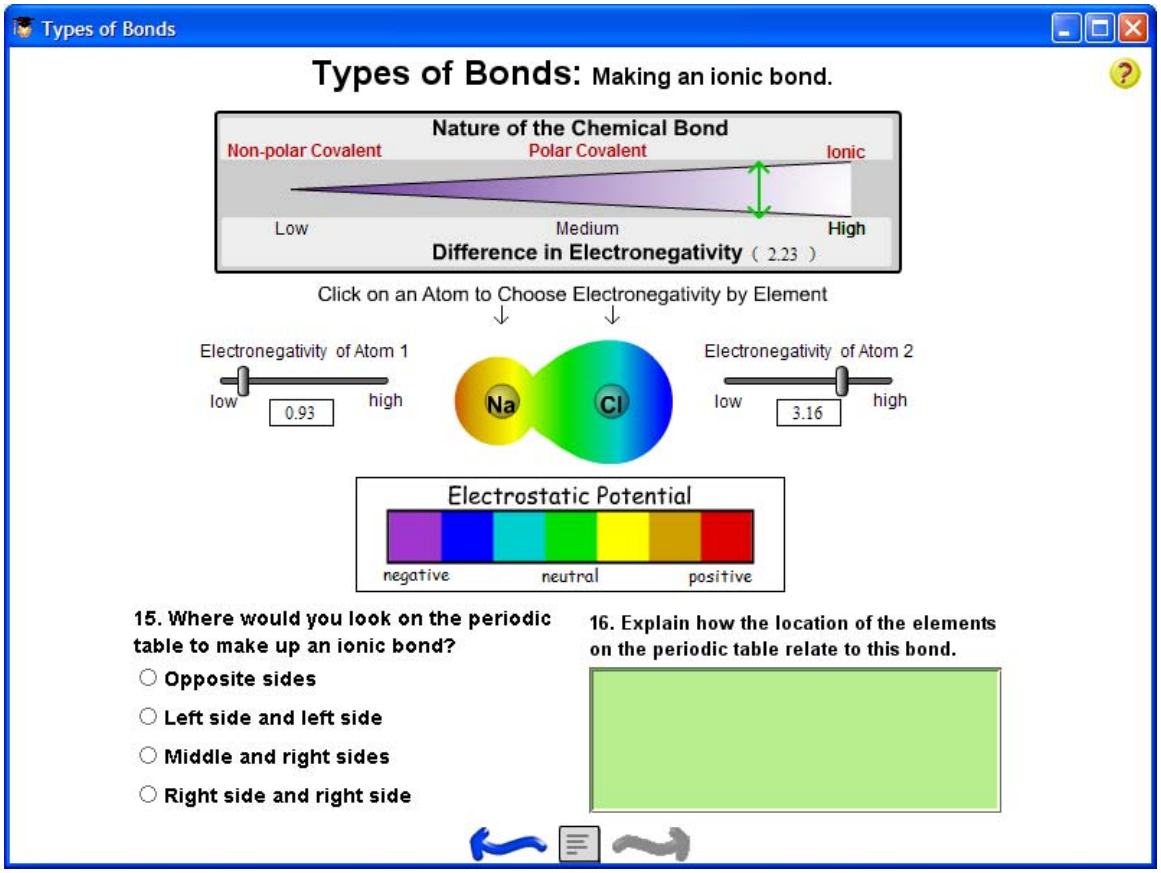

Check Hints for help!

The following Periodic Table window will open.




Students click on an element to set that atom in the model. The periodic table is intended to give students a feel for how different regions of the table have different EN's. Please note that EN is highest in the upper right and lowest in the lower left. This is because non-metals want to gain electrons and metals want to loose electrons.

When a student believes that s/he has an ionic bond, s/he should click the "Check" button. This will test the hypothesis. If the bond is correct, the student can continue to the next screen.




The next screens are similar except for the fact that the student must construct a covalent (non-polar) bond. To do this, s/he must select two identical or close non-metals from the right side of the table. These non-metals share electrons to form a chemical bond.

## 4.5 Questions for understanding

Question 14 asks students to begin to think about the affect of polarity on molecules. Water, which is a polar molecule, has surface tension, cohesion and adhesion. The molecular attraction between these molecules accounts for these properties.

Questions 20 and 21 ask students to compare the boiling point of carbon monoxide to that of hydrogen chloride. Students should be encouraged to use the model to determine which of these molecules has more polarity. The more polar molecule is going to have more attraction for other molecules and therefore will have a higher boiling point. Hydrogen chloride has a higher difference.

Questions 22 and 23 ask students to determine which of these substances has the lowest boiling point: hydrogen gas, chlorine gas, water or steel. Steel is the correct answer because it is the only solid.

### 4.6 Summary

This section shows the answers to all the questions in the activity. There is an icon on the lower left that will print each student's answers. After the students click the icon, s/he will be asked to type in her/his name. This is only for the printout; student names are not saved in our database. Then, a web page is generated with the answers. This process may take a few moments. The standard print dialog box will open and the student can select the appropriate printer.

## 5.0 Student Reports

Your students' work with the "Types of Bonds" activity is logged and viewable on the MAC Project Web Portal at http://mac.concord.org. For each student, you can view a report containing questions and answers.

The next activity in the Chemica sequence is "States of Matter."