Lesson Title: Ionic Bonds vs Covalent Bonds

Grade/Age Level:
high school chemistry, ages 15-18

Subject Area:
high school chemistry

Time allotted for the lesson:
2 class meetings
Day 1: What are ions and how they form
Day 2: Introduce periodic table chart of electronegativities and the chart I made to help students see if two atoms will tend to form ionic or covalent compounds

Short description of lesson:
In this lesson, the learners will be introduced to the idea that the electrons surrounding the nucleus can either be gained or lost. If the number of electrons stays the same, then perhaps the atoms are involved in a covalent bond.

To get an idea of whether two atoms will form an ionic or a covalent bond, they can use a periodic table that lists electronegativity values. Based on the difference in electronegativity values, the atoms will either swap electrons or share them.

California Curriculum Standards met in this lesson:

Chemical Bonds

Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules. As a basis for understanding this concept:
- Students know atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.
- Students know salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.

Instructional Objectives:
• Students will be able to evaluate two atoms to determine what type of bond will form.
• Students will be able to explain why ionic bonds tend to form crystalline structures.
• Students will be able to explain what it means to gain or to lose an electron.

Instructional Procedures

Lesson Set

In a discussion forum, pose the following questions:
Do you salt your food? Do you realize that by salting your food you are exposing yourself to ions?
How alarmed should we be that we consume ions?

Techniques and activities

Day 1

Review what makes up the structure of atoms.
If students need to review online, they can go to:
http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/atomic/atomstructurev1.shtml

Review what can change in number for atoms.
For example, changing proton number changes the type of atom. Changing neutron number creates an atom of the same substance, but with a different molecular weight. Changing the number of electrons changes the charge on the atom, which will therefore be called an ion.
This could be a quick pop up quiz if in a synchronous session or a one question Google form quiz if asynchronous.

Go over valence electrons and determine if an atom is more likely to gain electrons or to lose them.
There should be a worksheet or a blank periodic table where students can write down information about valence electrons and expected charges. Note: to be stable, each atom wants 8 valence electrons unless it is a really small atom that is stable with 2 electrons in its valence shell. I will ask students if the atom we are examining is more likely to gain one electron or lose 7 if it has 7 valence electrons. If it has 2 valence electrons, is it more likely to gain 6 or lose 2? That type of questioning.
I don’t know how to make an interactive PowerPoint presentation, but I know it can be done. I make a video of PPT slides where I ask questions, they get to answer with multiple choice options. Instant feedback.

Use the image I made to have students explain why the ions are organized in a cubic manner with alternating positive and negative ions.
This would probably have to be a short paper they turn in to a dropbox.
Day 2

Introduce the periodic chart of electronegativities.
Use the chart to calculate differences in electronegativities.
A chart can be found online at:
http://chemwiki.ucdavis.edu/@api/deki/files/4756/=electronegativity_chart.png

Use the image I made to determine if pairs of atoms will bond, and if they bond, what type of bond they will perform.
There should be a worksheet or a Google form where they can do this work.

Go over how crystalline structures allow the ions to be organized.
The image I used to figure out how to align my ions is here:
http://www.shutterstock.com/subscribe.mhtml

Other images that students can look at so they can see ionic crystalline structures are:
http://0.tqn.com/d/chemistry/1/0/q/p/Sodium-chloride-3D-ionic.jpg

Lesson Closure

There are many things that could be used for closure such as:

- Worksheets where they reinforce what they learned in this lesson set.
- Viewing images of salt crystals and solid molecular compounds and trying to figure out how you can tell what is an ionic crystal
- Students write a story where the importance of being able to gain or lose electrons is stressed vs sharing electrons.
- Students try to draw a crystalline structure.
- Students make a crystalline structure in jmol or other molecule building software.

Adaptations for special learners

- For those who want auditory support, create a verbal version of the webpages or handouts to accompany them.
- For students who need kinesthetic support, you can probably buy atoms that have Velcro on them that lets you add or remove electrons. If not, then you can probably make some.
- Also for kinesthetic support, I made ion puzzle pieces. Students moved the puzzle pieces to see why compounds like MgCl2 exist and why ionic formulas are not all 1:1 ratios.
- You could make puzzle pieces that let you add or remove electrons.
- If I knew how to write software that lets students interact with images, then I could have them add or remove electrons to create the ions.

Supplemental Activities: Extension and remediation
Extension: What would be incredibly challenging is to have students draw an ionic crystal that has a 1:2 or a 2:3 ratio for the ions.

Extension: A natural extension activity is to move into how to write formulas for ionic compounds. Since I wanted to focus on covalent molecules and the shapes of covalent molecules for this unit, I did not elaborate on more ionic formula lessons here.

Extension: Usually after students have an idea of what makes an ionic compound, they learn how to write the formulas and names for them.

Remediation activities could involve having students draw Bohr model pictures of the atoms. Then they identify the valence electrons. Once they figure out how many valence electrons are in each atom, then they determine if an atom is more likely to lose electrons to then have a stable outer layer, or will it tend to gain electrons?

Assessment/Evaluation

Most of the assessment will be formative.
The teacher reviews the answers to the worksheet questions with them so that students can monitor their own progress.

Students could draw Venn diagrams to contrast ionic and covalent compounds, with the idea that they will be adding to the diagram as the unit continues.

Students are to download a copy of jmol
http://jmol.sourceforge.net/
Using jmol, they are to make an ionic crystalline structure. It could be as simple as NaCl. They take a snapshot of the “cube” they made and upload it to the dropbox. Note: I am not sure yet if they can do a crystal in jmol. I’d have students do it in HyperChem, but it costs money. Jmol is free.

Learner Products

- Completed worksheets on determining if a formula is for an ionic or for a covalent compound
- Venn diagram that contrasts ionic and covalent molecules
- Drawing of a crystalline structure for an ionic compound
- Jmol image of a crystalline structure for an ionic compound