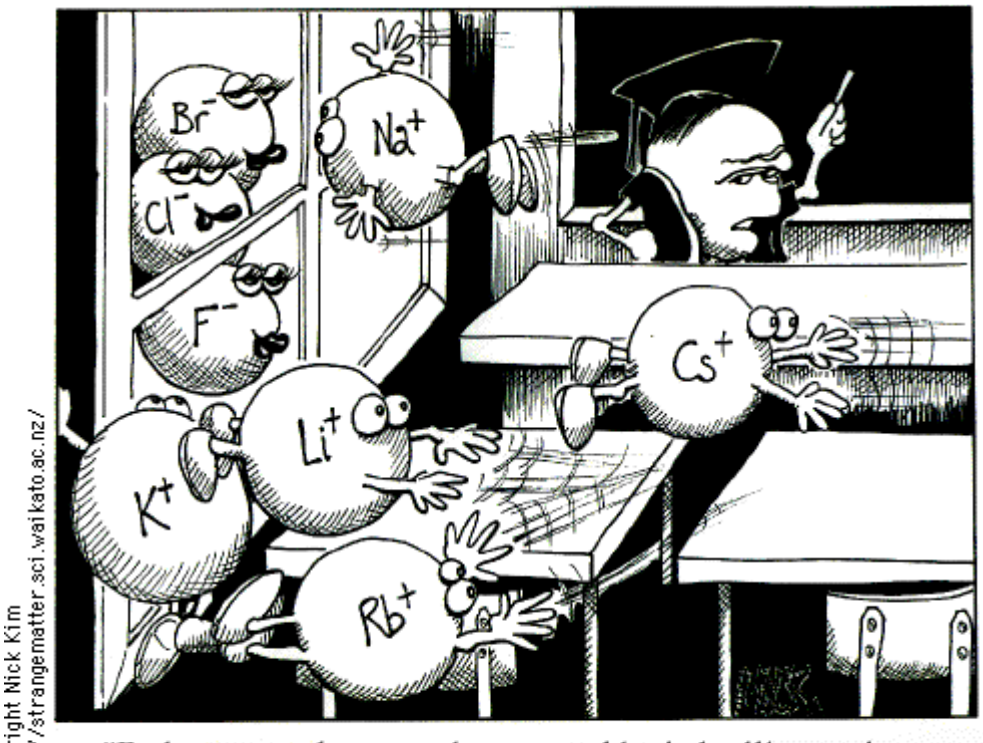
Basics of Ionic and Covalent Bonding
Lewis Dot diagrams



"Perhaps one of you gentlemen would mind telling me just what it is outside the window that you find so attractive...?"

C. Souders- Battlefield

Standard of Learning

SOL CH.3 d: The student will demonstrate an understanding of various bonding processes and the properties associated with each.

Essential Question(s)

- How are chemical bonds classified?
- How does the bond type affect properties?
- How are electron dot diagrams used to represent compounds?

Unit: Bonding
Lesson: Ionic vs Covalent (Lewis Dot diagrams)
Time Frame: 120 minutes (1.5 blocks)

PWCS Standards Based Planning Process

Standards: ***What will students know and be able to do?***

Essential Understanding -

- Many chemical bonds can be classified as ionic or covalent.
  - Ionic bonds are indicated by transfer of electron(s) from one atom to another.
  - Covalent bonds are indicated by sharing of electron(s) by two atoms.
- Compounds have various properties depending on bond type.

- Electron dot diagrams can be used to represent ionic and covalent compounds.

Essential Skill –

- Based upon the bond types formed in a compound, predict the physical properties of the compound with respect to selected properties such as conductivity, boiling point, freezing point and any chemical properties that affect is ability to undergo reactions.

- Use drawings of the Bohr model of the atom to illustrate the electron distribution of the bonds in covalent, ionic, and polar bonds.

- Use the Lewis Dot concept to illustrate the formation of covalent bonds, including single, double, and triple bonds where applicable.

Assessment: ***How will the student and I know when he/she is successful?***

- **Before Lesson (Pre-Assessment) –** In the previous unit students studied electron configurations. Test results from this unit should be a clear indication on whether students are ready to move on. The teacher will start the lesson with the warm-up assignment provided. This should refresh students memories on the topic and give a good amount of pre-assessment data. The teacher will go through the correct answers to the warm-up by asking students to put answers on the board. It is important that all students have the correct answers before the new topic is discussed because the warm-up will be referenced throughout lecture.
- **During Lesson (Formative) –** As new concepts are introduced the teacher should regularly ask for feedback from students. If a sample problem is presented to students the teacher should then ask the students to replicate the same concept on their own, then ask for the correct answer. It is important to consistently question the difference between ionic and covalent bonds once they have both been introduced. Students tend to mold these into one new type of fictional bond.
- **After Lesson (Summative) –** There is a quiz presented to show mastery on this particular lesson. This lesson is most likely part of a larger unit that will have a cumulative test to show mastery of the entire unit. Students should be able to identify the differences between an ionic and a covalent bond and create formulas based off the elements they are presented with.

Task Analysis: ***What knowledge, skills and level of understanding do students need to be successful with this lesson?***

- **Pre-Assessment Data:** This unit follows units on the periodic table and electron configurations.
  - Students should be able to correctly identify metals, semi-metals and non-metals on the periodic table.
  - Students should be able to correctly write an electron configuration for a given element.
  - Students should be able to identify the energy levels in their electron configuration and which is the highest energy level and how many electrons are present.

. **Important Vocabulary (Literacy) –**

Ionic bond
Ionic Compound
Covalent bond
Covalent (molecular) compound
Valence electrons
Electron (Lewis) dot diagram
Cation
Anion
Octet Rule
Diatomic molecules
Single covalent bond
Double covalent bond
Triple covalent bond
Polyatomic ions
Superscript
Subscript

- **Skill Development and Differentiation-** Students should be coming into this lesson with a brief knowledge of ionic and covalent bonding from middle school science.
  - Ionic compounds – the "Bond-Switch-Bond" activity allows students to work at their own pace creating compounds. It also allows students who understand the topic to work with many students who may not be as clear. They can use their abilities to help someone else to understand.
  - When identifying ionic and covalent compounds students should ALWAYS first identify if the compound contains two metals or a metal and non metal.
  - Covalent compounds - "Covalent Compound Bingo Chip Challenge" activity allows students to be paired up by teacher choice. Students with a better understanding can be paired with a student who struggles a bit more. This will create peer teaching and allow both levels of students to excel. The activity also offers an extra option for students who have a strong grasp on the topic. This will allow them to explore the concept on a deeper level.
  - The two video clips should offer a good visual reference for visual learners. The videos show the concept of sharing and gaining/losing electrons with motion.
  - The graphic organizer comparing ionic and covalent bonds should help students to organize their thoughts and the concepts being taught. Asking them to re-organize their thoughts by using only key words should help them to conceptualize the topics.

Instruction Using Inquiry Model: ***What learning experiences will facilitate student success?***

Framing the Learning:

1. **Engage –** Begin class with the warm-up provided. This will reconnect students to past lessons. Ask students to complete the warm-up, then choose a few students to write the answers on the board. It is important to go over the answer with the students and make sure everyone has the correct answers to the warm-up because they will be referenced throughout the lesson.

Learning Experiences:

2. **Explore –** There are two activities in this lesson, "Bond-Switch-Bond" and "Covalent Bond Bingo Chip Challenge," the ancillary materials necessary for both of these activities will be found later in the lesson.
    - In "Bond-Switch-Bond" teachers need to make sure that students are understanding that an ionic bond is a combination of a positive and a negative charge. Be sure students are not allowing two positive or two negative charges to combine to make a compound. Also, teachers need to make sure students are understanding the concept of "crossing and dropping" when writing a chemical formula for an ionic bond. Students tend to keep superscripts instead of creating subscripts, or they leave both.
    - In "Covalent Bond Bingo Chip Challenge" teachers will need to make sure students are actually 'building' the dot diagrams so that they can see how the elements fit together and share electrons. Teachers also need to make sure that students are writing the formula correctly. After learning about ionic bonds students get caught up on the 'cross and drop' method and start to write covalent formulas incorrectly. This is a 'challenge' because they are given a time limit of 15 minutes and the group that has the most correct will win.

3. **Explain –** A power point with necessary information is included. Students usually grasp the concept of ionic bonding easily, then as soon as you add in covalent bonding they begin to struggle in recognizing the difference. There is a handout included for students to fill in and summarize the difference between ionic and covalent bonds. This is an important handout for students to use as a quick reference in the future.

4. **Elaborate –** There are handouts included for both ionic and covalent bonding. It is up to the discretion of the teacher on whether or not more practice is needed. Both exploration activities could be repeated or given extended time if more practice is needed. They can also be altered to focus on whatever issues the students are having.

5. **Evaluate –** A quiz on ionic and covalent bonding is attached. It is a written formal assessment that will show mastery of the topic. You may choose to give to use some of these questions to check for understanding during lecture.

PWCS Standards Based Planning Process (continued)

Resources:

- Bonding warm-up
- Bonding PowerPoint
- Ionic Video Clip http://www.dnatube.com/video/1288/Ionic-bond
- Covalent Video Clip http://www.dnatube.com/video/1290/Covalent-bond
- Ionic/Covalent graphic organizer handout for each student
- Bond-Switch-Bond handout for each student, printed and laminated cards for each student, and instructions.
- Ionic Handout for each student
- Covalent Bond Bingo Chip Challenge handout, printed and laminated cards for students and instructions.
- Covalent Handout for each student
- Ionic/Covalent Bonding Quiz

Reflection: ***Based on data, how do I refine the learning experiences and/or the assessment?***

- **Analysis of Data –** As with many topics in chemistry, a strong understanding of this lesson is imperative in the next unit, nomenclature. If students struggle through the quiz and/or activities it is important for the teacher to go back and reinforce the missed information. Assessments on this topic will continue throughout the curriculum.

- **Immediate Implications –** Again, if students are struggling it is important to review materials immediately to conquer any mis-conceptions. If students have met the mastery level then reviewing the concept of electronegativity in order to be more detailed about covalent bonding will be used in the next lesson.

- **Future Planning –** Although bonding is usually taught in middle school, this lesson is vital to students success in future lessons. It is important students understand the difference between an ionic and a covalent bond and that this is reinforced in future lessons.

SOL CH.3 d: The student will demonstrate an understanding of various bonding processes and the properties associated with each.

Name: _____

Class Period: _____ Date: _____

ENGAGE PHASE

Bonding Warm-Up

Name:_____

Warm-Up

Write the electron configuration for the following …

1. Na
2. K
3. Li
4. Cl
5. O

Name:_____

Warm-Up

Write the electron configuration for the following …

1. Na
2. K
3. Li
4. Cl
5. O

Name:_____

Warm-Up

Write the electron configuration for the following …

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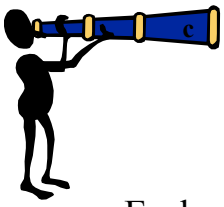


Bond – Switch – Bond

- Each of you will be given an ion card.
- You will wander around the room with your hand in the air, when you come in contact with another person slap hands, they are your bonding partner.
- Write down the positive ion and the negative ions that the two of you possess (If you do not have opposite ions you cannot bond and you need to start mingling again) and create your compound.
- After you and your partner have created (or eliminated the ability to create) a compound, swap ions with each other and roam the room with your hand in the air again.
- When you find another partner, slap hands, introduce yourself to your new bonding mate and continue to roam the room.

Cation	Anion	Compound

Ga^{+4}	Sr^{+2}
Rb^{+1}	In^{+3}
As^{-3}	Sb^{-3}
Cs^{+1}	Ba^{+2}

This is an excel file. Double click on the 'cards' to open excel and gain access to all of them.

Name: _____

Covalent Compound Bingo Chip Challenge

Class Period: _____ Date: _____

1. You and a partner will be given a bag of bingo chips and a bag of element cards.
2. You will have 15 minutes to create as many covalent compounds as you can using no more than two elements in each compound.
3. You must use the element card and bingo chips to build the dot diagram for each element in your compound to make sure they fit.

DOT DIAGRAM ELEMENT 1	DOT DIAGRAM ELEMENT 2	DOT DIAGRAM COMPOUND	FORMULA

*If you need more of a challenge you may build compounds using more than two different elements in each compound. Build a chart on the back of this paper if you need more space.

B	C	N
B	C	N
B	C	N
B	C	N

This is an excel file. Double click on the ‘cards’ to open excel and gain access to all of them.

Name: _____

Class Period: _____ Date: _____

SOL CH.3 d: The student will demonstrate an understanding of various bonding processes and the properties associated with each.

EXPLAIN PHASE

Ionic vs Covalent Bonding

This is a powerpoint presentation. Double click on the title page to be taken to the full presentation.

Video Clips

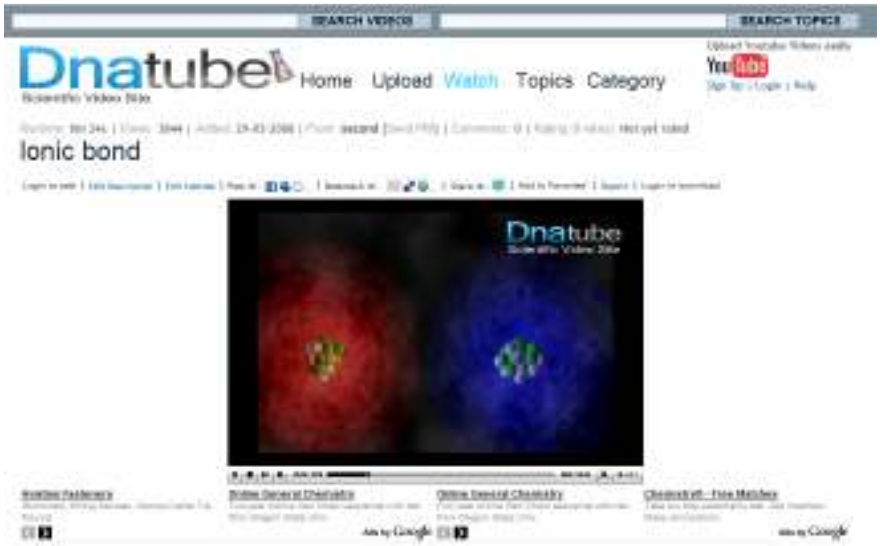
Source: www.dnatube.com

Title: Covalent Bond http://www.dnatube.com/video/1290/Covalent-bond

Length: 34 seconds

Summary: This video clip shows an animated representation of a covalent bond. It shows how the electrons are "shared" passing back and forth between elements.

Title: Ionic Bond http://www.dnatube.com/video/1288/Ionic-bond



Length: 23 seconds

Summary: This video clip shows an animated representation of an ionic bond. It shows how electrons from one element are given up to another element in order to satisfy the octet rule.

Summarize what you have learned about covalent and ionic bonds in this easy to read chart. Be sure to include things like properties, how the octet rule applies, what makes up each type of bond, etc.

Ionic Bonds	**Covalent Bonds**

Name: _____

SOL CH.3 d: The student will demonstrate an understanding of various bonding processes and the properties associated with each.

Class Period: _____ Date: _____

ELABORATE PHASE

Ionic Bonds

The Periodic Table of the Elements

1 **H** Hydrogen 1.00794																	2 **He** Helium 4.003
3 **Li** Lithium 6.941	4 **Be** Beryllium 9.012182											5 **B** Boron 10.811	6 **C** Carbon 12.0107	7 **N** Nitrogen 14.00674	8 **O** Oxygen 15.9994	9 **F** Fluorine 18.9984032	10 **Ne** Neon 20.1797
11 **Na** Sodium 22.989770	12 **Mg** Magnesium 24.3050											13 **Al** Aluminum 26.981538	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.973761	16 **S** Sulfur 32.066	17 **Cl** Chlorine 35.4527	18 **Ar** Argon 39.948
19 **K** Potassium 39.0983	20 **Ca** Calcium 40.078	21 **Sc** Scandium 44.955910	22 **Ti** Titanium 47.867	23 **V** Vanadium 50.9415	24 **Cr** Chromium 51.9961	25 **Mn** Manganese 54.938049	26 **Fe** Iron 55.845	27 **Co** Cobalt 58.933200	28 **Ni** Nickel 58.6934	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.723	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92160	34 **Se** Selenium 78.96	35 **Br** Bromine 79.904	36 **Kr** Krypton 83.80
37 **Rb** Rubidium 85.4678	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.90585	40 **Zr** Zirconium 91.224	41 **Nb** Niobium 92.90638	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.90550	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.8682	48 **Cd** Cadmium 112.411	49 **In** Indium 114.818	50 **Sn** Tin 118.710	51 **Sb** Antimony 121.760	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90447	54 **Xe** Xenon 131.29
55 **Cs** Cesium 132.90545	56 **Ba** Barium 137.327	57 **La** Lanthanum 138.9055	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.207	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.217	78 **Pt** Platinum 195.078	79 **Au** Gold 196.96655	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.3833	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98038	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

58 **Ce** Cerium 140.116	59 **Pr** Praseodymium 140.90765	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.964	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.92534	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93032	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93421	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.967
90 **Th** Thorium 232.0381	91 **Pa** Protactinium 231.03588	92 **U** Uranium 238.0289	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

1. Fill in the following chart

ELEMENT	ATOMIC SYMBOL	TOTAL# OF ELECTRONS	# OF VALENCE ELECTRONS	# OF ELECTRONS GAINED/LOST	DOT DIAGRAM
Chlorine					
Potassium					
Magnesium					
Fluorine					
Aluminum					
Sodium					
Nitrogen					
Oxygen					
Carbon					
Iodine					

2. Write the electron configuration for both Sodium and Oxygen.

a. Will these form positive or negative ions?

b. Write out their dot diagrams.

c. What ratio will they combine?

d. Write the formula of Sodium Oxide.

3. Write the electron configuration for both Alumnium and Oxygen.
   a. Will these form positive or negative ions?

   b. Write out their dot diagrams.

   c. What ratio will they combine?

   d. Write the formula of Alumnium Oxide.

4. Write the correct chemical formula for the compounds formed from each pair of ions.

   a. K^{+}, S^{2-}
   b. Ca^{2+}, O^{2-}
   c. Na^{+}, O^{2-}
   d. Al^{3+}, N^{3-}

5. Which pairs of elements are likely to form ionic compounds? If they will form a compound, write the correct formula.

   a. Cl, Br
   b. Li, Cl
   c. K, He
   d. I, Na

SOL CH.3 d: The student will demonstrate an understanding of various bonding processes and the properties associated with each.

Name: _____

Class Period: _____ Date: _____

Covalent Bonds

Table B.8

Names and Charges of Polyatomic Ions

1– charge		2– charge		3– charge	
Name	**Formula**	**Name**	**Formula**	**Name**	**Formula**
Chlorate	ClO_3^-	Carbonate	CO_3^{2-}	Phosphate	PO_4^{3-}
Chlorite	ClO_2^-	Chromate	CrO_4^{2-}	Phosphite	PO_3^{3-}
Cyanide	CN^-	Dichromate	$Cr_2O_7^{2-}$		
Dihydrogen phosphate	$H_2PO_4^-$	Oxalate	$C_2O_4^{2-}$	**1+ charge**	
Ethanoate	CH_3COO^-	Peroxide	O_2^{2-}	**Name**	**Formula**
Thiosulfate	$S_2O_3^{2-}$	Silicate	SiO_3^{2-}	Ammonium	NH_4^+
Hydroxide	OH^-	Sulfate	SO_4^{2-}		
Hydrogen carbonate	HCO_3^-	Sulfite	SO_3^{2-}		
Hydrogen sulfate	HSO_4^-				
Hydrogen sulfite	HSO_3^-				
Hypochlorite	ClO^-				
Nitrate	NO_3^-				
Nitrite	NO_2^-				
Perchlorate	ClO_4^-				
Permanganate	MnO_4^-				
Thiocyanate	SCN^-				

You are responsible for knowing the Polyatomic Ions, formulas and charges.

1. Describe what a molecular compound is. Explain how a molecular formula is the chemical formula of a molecular compound.

2. Give an example of a diatomic molecule found in Earth's atmosphere.

3. Describe how the molecule whose formula is NO is different from the molecule whose formula is N_2O.

4. How are the melting points and boiling points of molecular compounds usually different from those of ionic compounds?

5. What electron configurations do atoms usually achieve by sharing electrons to form covalent bonds?

6. How is an electron dot structure used to represent a covalent bond?

7. Draw electron dot structures for the following molecules:

    a. H_2S

    b. PH_3

    c. ClF

    d. Fluorine + Fluorine

    e. 3 Hydrogen + 1Phosphorus

    f. 2 Hydrogen +1Sulfur

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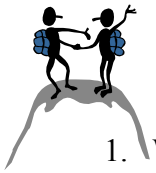

EVALUATE PHASE

Ionic/Covalent Bonding Quiz

1. What are valence electrons?

2. What is one way that you can find the number of valence electrons for a representative element?

3. Draw the electron dot diagram for Fluorine. What does the dot diagram tell you?

4. Write the correct ionic compound formulas for the following ion combinations:
   a. Potassium and Oxygen

   b. Mg^{2+} and Cl^{1-}

   c. Lithium and Chlorine

   d. Aluminum and Oxygen

   e. Nitrogen and Sodium

   f. Na^{+} and Cl^{-}

5. A Cation has a _____ charge.

6. An Anion has a _____ charge.

7. Covalent bonds are between a non-metal and a_____ while ionic bonds are between a non-metal and a _____.

8. Which has higher melting and boiling points, ionic or covalent bonds?

9. Explain the difference between the octet rule for ionic bonds and the octet rule for covalent bonds. Draw images to help your description if necessary.

10. Circle the IONIC bonds below:

NaCl	CH_4	SO_2	Li_2O	MgS	H_2O

11. Circle the COVALENT bonds below:

BeO	$N0_2$	LiBr	KF	BaO	CO_2

12. Draw the electron dot structures and formula for the following covalent compounds:
    a. 1 Phosphorus and 3 Chlorine

    b. 2 Hydrogen and 1 Sulfur