CE - 1

DESCRIPTION OF STUDENTS' MISCONCEPTION IN CHEMICAL BONDING

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Abstract

Chemical bonding is one of concept that is taught in basic chemistry. Due to its abstract concept, many students have difficulties to understand it. This study aimed to investigate students' misconception of chemical bonding that involved chemistry education students at Faculty of Education Tanjungpura University. Survey method was applied to obtain students' misconception using diagnostic test as well as interview. The result shows that students had difficulty to determine the type of bonding in metallic and non-metallic elements (79%). Determining the type of bonding based on electronegativity difference is also become for students; that is 47%. The third difficulty is to write Lewis structure of molecule that is ionic bonding and covalent bonding; it is 68 %. Meanwhile, 73% students could not determine pair of compounds in ionic and covalent bonding.

Key words: misconception and chemical bonding.

INTRODUCTION

Chemistry concepts consist can be visualized in some forms suchas submicroscopic, macroscopic, and symbolic. According to Eny, Hairida and Mulyati (2004), application of chemistry in daily life must be correcly begun with an understanding of concepts, principles, laws, and chemical theory. However, chemistry is one of the subjects that is difficult understood by students. Many students have difficulties to understand concepts and principles of chemistry. Difficulty in studying chemistry is caused by chemical materials interrelated with each other, so if a student has experienced an error in the concept of chemistry, it will inhibit the link between the concept of one and each other (Mary B. Nakhleh, 1992).

According to Effendy (2002), generally a concept in chemistry is an abstract concept, so it requires a good understanding in learning chemistry. Chemical bonding is one of the abstract material and far from daily experience. For example, we cannot see atoms, the structure, and how the reactions with other atoms (Nicoll in Haluk Ozmen, 2007); consequently these materials become difficult to be grasped by students. Misconception may occur in the pre conception by students. Learners have brought pre conceptions of daily life before following the formal learning process. According to Paul Suparno (2013), the concept which brought by students sometimes are not appropriate with the scientific concepts which presented by experts so that it can cause misconceptions.

Misconceptions also can occur to students after they have learned the concept. Chemical bonding material has previously been studied in high school students then learned in college on the Basic Chemistry I, but more than 70% of students achieved under 70 in score (including senior

students who took Basic Chemistry I 2014). Students' performance showed that there were some misconceptions on chemical bonding material. This is also found by David F. Treagust's (1989)

Research conducted by Keith S. Taber (1997) showed that a high percentage of students have misconceptions about the lattice structure of sodium chloride and how ionic bonding. A study of students's misconceptions conducted Nicoll (2001) in Haluk Ozmen (2007) showed that misconceptions occured in atoms, molecules, the formation of chemical bonds, bond polarity, Lewis structure, the polarity of the molecules, and the type of chemical bond. According to Paul Suparno (2013), the causes of misconceptions on students are students themselves, teachers, textbooks and learning methods. Misconceptions occur repeatedly, such as senior students who gained low learning outcomes. It shows that the understanding of the concept is still intact and need to be resolved by finding the cause of misconceptions. A complex concept can only be mastered properly if the basic concepts have been mastered properly (Sihaloho, 2008). Yuyu (2005) managed to find out how much the students' understanding of physics concepts, so that remediation of misconceptions can be performed on such material. Based on the explanation needs to be done research to describe the students misconceptions in chemical bonding material.

The aim of the study is to determine the percentage of students who have misconceptions, wrong concepts and do not know the concept. This study is expected to provide information about the misconceptions that still occur in senior students in chemistry bonding material, so that it can be done improvement in the correct concept. Those efforts need to be done because chemistry education students are candidates chemistry teacher who will teach chemistry concepts at school. So if there are misconceptions on the teachers, student will also have misconceptions. According to Paul Suparno (2013) the cause of misconceptions when teaching occurs in two ways, namely teachers do not master the concepts of right and wrong even though the teacher explains the concepts taught correctly.

RESEARCH METHOD

This study used descriptive type of survey research. The survey was conducted to obtain information about the causes of student misconceptions in chemical bonding material. The subjects were 19 senior students who took Basic Chemistry courses II. Five multipe choice test with reason were administered to collect the data.

RESULT AND DISCUSSION

Based on students' answer and confident leve, the result shows that the percentage of students who know the concept is 37.7%; do not know the concept is 11.7%; and have misconceptions is 50.6% which can be seen in Table 1.

Table 1. Percentage of students who know the concept, do not know the concepts and misconceptions.

Indicator	Question items	Know the concepts (%)	Do not know the concepts (%)	Misconceptions (%)
Determining the type of bonding of a compound based on the difference in electronegativity	1	84,2	-	15,8
	2	21	26,3	52,7
Mention the type of bonding that may occur when metal and non-metal elements bind	3	21	-	79
Write down the Lewis structure of a molecule that binds ions	4	31,5	11,5	58

Write down the Lewis structure of a molecule that is covalently bound	5	31,5	21	47,5

Discussion

Question 1

Salt formed from the ions Na^+ and Cl^-. Based on these data types of bonding of molecules of NaCl after binding (by considering the ionic character after both constituent element binding) is a ..... bond.

a. Ionic
b. Non polar covalent
c. Covalent coordination
d. Polar covalent
e. Metal

Based on question 1, 15.8% of the students still have misconceptions because it considers the formation of ionic bonds based on metallic and non-metallic properties of an element and only anions and cations that will form ionic bonds. The concept which owned by student is incompatible with the conception of scientists so it causes misconceptions. Conception of scientists in this question is a binary compound that has more than 1.7 electronegativity difference will form compounds that bind ions (Effendy, 2008). Electronegativity values of Na = 0.93 and Cl = 3.16, then the difference in electronegativity is 2,23. This value indicates that the compound NaCl has an ionic bond.

Question 2

Wurtzit crystalline compounds contains zinc sulfide (ZnS). Zinc can form Zn^{2+} ions while sulfur can form S^{2-} ions. Based on these data, the type of bonding molecules ZnS that may be formed (by considering ionic character after both of the constituent element binding) is a ... bond.

a. Ionic
b. Non polar covalent
c. Covalent coordination
d. Polar covalent
e. Metal

Based on an question 2, the percentage of students who did not know the concept is 26.3% meanwhile 52.7% of students have misconceptions. Students experienced a misconception because it considers the formation of ionic bonds based on metallic and non-metallic properties of an element and by anions and cations that will form ionic bonds. Conception scientists on this question similar with the question number 1 that the binary compound that has the electronegativity difference of less than 1.7 will form covalent bonds with polar compounds (Effendy, 2008). Electronegativity value of Zn = 1.65 and S = 2.58, then the difference in electronegativity is 0.93. This value indicates that the ZnS tend to form covalent compounds after binding.

Based on the results obtained the causes of student misconceptions on question 1 and 2 are wrong intuition and incomplete reason. Intuition which emerged from students are metal and non-metal elements certainly form ionic bonds, which students observe from a few examples in the book, but not all ionic compounds formed from metal and non-metal elements. The incomplite reason were caused by students were not using the data in electronegativity value at the time will determine the type of bonding in ionic and covalent compounds.

Question 3

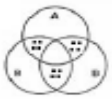
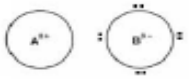
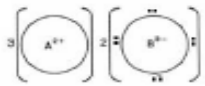
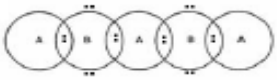
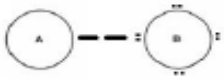
$BeCl_2$ and CaF_2 are examples of a compound formed from metal and non-metal elements. Based on the exposure, the type of bonding that occurs when metallic and non-metallic elements forming compound is ....

a. Ionic bond
b. Coordinate covalent bond
c. Metal bond and ionic bond
d. Ionic bond and polar covalent bond
e. Ionic bond and non-polar covalent bond

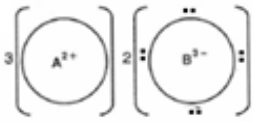
Based on question 3, students (79%) still have misconceptions because they believe that every element of the metal and nonmetal certainly will form ionic bonds. The conception of scientists in this question is the metal and non-metal elements can form ionic compounds or covalent bound depends on the percentage of ionic character. Binary compound that has more than 1.7 electronegativity difference will form compound that bind ion while compound that has less than 1.7 electronegativity difference will form polar covalent compounds. $BeCl_2$ compounds have 1.5 electronegativity difference so that it has a covalent bond while CaF_2 compound 3.0 electronegativity difference so that it has an ionic bond (Effendy, 2008). At question 3 misconception occurs because students assume that Cl atom in $BeCl_2$ compound attract two electrons of the atoms Be, At question 3 misconception occurs because students assume that Cl atom in compound $BeCl_2$ attract two electrons of the atoms Be, while F atom in compound CaF_2 attract two electrons from Ca atom. Cl atoms and F will be negative ions are $2Cl^-$ and $2F^-$. Students are less careful in writing, giving rise to the incompleteness of reasons. The teacher writes that the Cl atom and F attract two electrons of the atoms Be and Ca, whereas if the Cl atom and F attract two electrons, the valence electrons is 9.

Question 4

A element has the atomic number 20 and the B element has an atomic number 7, then the picture of Lewis structures that may be formed is ....

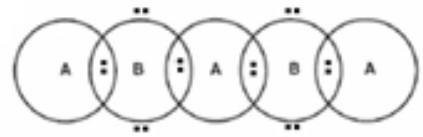
a. 
b. 
c. 
d. 
e. 

Based on question 4, there are 11.5% of students did not know the concept and 58% of college students have misconceptions. Conception of scientists to this question is in forming a compound, both of the elements must fulfill the octet rule that has 8 valence electron. IIA group elements tend to release two electrons and form A^{2+} ions, while the VA groups tend to accept three electrons and ions form B^{3-}. The stability of these two elements when forming compounds is to make a charge neutral compound A_3B_2 (James Armstrong, 2012). Lewis structure of A_3B_2 compounds according to the conception of scientists presented in Picture 1.



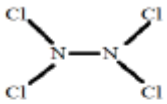
Picture 1. Lewis Structure A_3B_2 compounds based on the conception of scientists.

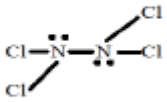
Students' misconceptions occured because the students are in correct to determine Lewis structure picture of an ionic bond. Students are correct in writing the formation of ionic compounds, but the students are incorrect in determining Lewis structure of A_3B_2. This misconception caused by reasons that are not fully in writing Lewis structures of ionic compounds. Students make a choice on the covalent bonds of Lewis structure without thinking about the truth of the answer choices. Lewis structure of A_3B_2 compounds according to the student's conception is presented in Picture 2.

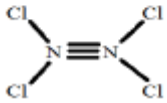


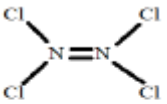
Picture 2 the misconceptions of students in illustrates the Lewis structure of A_3B_2 compounds.

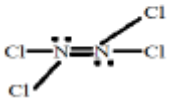
Question 5
Which of these following Lewis structures with right represent N_2Cl_4 ....

a. 

b. 

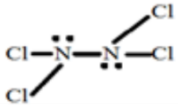
c. 

d. 

e. 

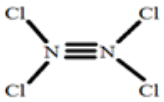
Based on question 5, there are 21% of students who don't know the concept and 47.5% of students experiencing misconceptions. Misconception occured because students always assume that nitrogen always make a triple bond with other nitrogen atoms when bonded to other atoms. Conception of scientists on this question is to form a compound both of elements must fulfill the octet rule which has 8 valence electrons. On this structure, the N element on group VA

tend to use one electron together with another atom or with fellow N whereas Cl which derived from VIIA group elements tend to use a pair of electrons together. N element still has one lone pair will be in the opposite direction because of the magnitude repulsion (James Armstrong, 2012). Lewis structure from N_2Cl_4 compound according to the conception of scientists presented in Picture 3.



Picture 3. The Lewis structure of the N_2Cl_4 compound based on the conception of scientists.

Misconception occured because students assume that nitrogen always make triple bond with other nitrogen atom if bonded to other atoms. This conception is less precise because there is a condition when the nitrogen element didn't make a triple bond with other nitrogen in a compound. Students associate each nitrogen atom which bonded to another nitrogen atom will have a triple bond regardless of another atoms which bonded to the N atom. Lewis structure from N2Cl4 compound according to the conception of student presented in Picture 4.



Picture 4. Student misconceptions in describing the lewis structure of the N_2Cl_4 compound.

CONCLUSION AND SUGGESTION

The conclusion in this research is the percentage of students who have correct concept is about 37.7%; do not know the concept are about 11.7%; and misconceptions are about 50.6%. The cause of students' misconception is because of incorrect intuition and incomplete reasons.

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