CONCEPTUAL CHANGE ORIENTED INSTRUCTION AND STUDENTS' MISCONCEPTIONS IN CHEMICAL BONDING CONCEPTS

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ABSTRACT

CONCEPTUAL CHANGE ORIENTED INSTRUCTION AND STUDENTS' MISCONCEPTIONS IN CHEMICAL BONDING CONCEPTS

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The main purpose of this study was to investigate the effects of conceptual change oriented instruction accompanied with analogies on eight grade students' understanding of chemical bonding concepts. In addition, the effect of instruction on students' attitude toward science as a school subject and the effect of gender difference on understanding of chemical bonding concepts were investigated.

Fifty eight-grade students from two classes of a science course taught by the same teacher in Büyükelçi Nazım Belger Primary School in the 2010-2011 spring semesters participated in the study. The study included two groups which were selected randomly throughout three classes. One of the groups was defined as control group in which students were instructed by traditionally designed science instruction, while other group was defined as experimental group in which students were instructed by conceptual change texts oriented instruction accompanied with analogies. Chemical Bonding Concept Pre-Test was administered to both groups as a pre-test and Chemical Bonding Concept Post-Test was administered to both groups as a post-test in order to assess their understanding of concepts related to chemical bonding. Students were also given Attitude Scale Towards Science as a School Subject at the beginning and end of the study to determine their attitudes and Science

Process Skill Test was used at the beginning of the study to measure their science process skills.

The hypotheses were tested by using analysis of covariance (ANCOVA) and two-way analysis of variance (ANOVA). The results indicated that instruction based on constructivist approach caused a significantly better acquisition of scientific conceptions related to chemical bonding and produced significantly higher positive attitudes toward science as a school subject than the traditionally designed science instruction. Also, science process skill was a strong predictor in understanding the concepts related to chemical bonding. On the other hand, no significant effect of gender difference on understanding the concepts about chemical bonding and students' attitudes toward science as a school subject was found.

KEYWORDS: Misconception, Conceptual Change Texts, Analogy, Traditionally designed Science Instruction, Chemical Bonding, Attitude Towards Science as a School Subject, Science Process Skill.

ÖZ

KAVRAMSAL DEĞİŞİM METNİ YAKLAŞIMINA DAYALI ÖĞRETİM VE ÖĞRENCİLERİN KİMYASAL BAĞLAR KONUSUNDAKİ KAVRAM YANILGILARI

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Bu çalışmanın amacı analoji ile destekli olarak hazırlanan kavramsal değişim yaklaşımına dayalı öğretimin sekizinci sınıf öğrencilerinin kimyasal bağlarla ilglili kavramları anlamalarına etkisini incelemektir. Aynı zamanda, öğretim yönteminin öğrencilerin Fen ve Teknoloji dersine yönelik tutumlarına etkisi ve cinsiyet farkının öğrencilerin kimyasal bağlarla ilgili kavramları anlamalarına etkisi de incelenmiştir.

Bu çalışma Büyükelçi Nazım Belger İlköğretim Okulu 2010-2011 bahar döneminde gerçekleştirilmiştir. Çalışmaya, aynı fen ve teknoloji öğretmeninin iki ayrı sınıfındaki elli öğrenci katılmıştır. Çalışma için iki grup oluşturulmuştur. Sınıflar kontrol grubu ve deney grubu olarak üç sınıf içerisinden rastgele seçilmiştir. Kontrol grubunda geleneksel yöntem kullanılırken deney grubunda analojilerle desteklenen kavramsal değişim metinleri kullanılmıştır. Öğrencilerin kimyasal bağlarla ilgili kavramları anlama düzeylerini ölçmek için Kimyasal Bağlar Ön Kavram Testi her iki gruba ön-test olarak ve Kimyasal Bağlar son Kavram Testi her iki gruba son-test olarak uygulanmıştır. Ek olarak, öğrencilerin Fen ve Teknoloji dersine yönelik tutumlarını belirlemek için Fen ve Teknoloji Dersi Tutum Ölçeği ve bilimsel işlem becerilerini belirlemek için Bilimsel İşlem Beceri Testi her iki gruba da uygulanmıştır.

Araştırmanın hipotezleri ortak değişkenli varyans analizi (ANCOVA) ve iki yönlü çok değişkenli varyans analizi (ANOVA) kullanılarak test edilmiştir. Sonuçlar yapılandırıcı yaklaşımın kimyasal bağlarla ilgili kavramların anlaşılmasında daha etkili olduğunu ve Fen ve Teknoloji dersine yönelik daha olumlu tutuma yol açtığını göstermiştir. Bilimsel işlem becerisinin de öğrencilerin kimyasal bağlarla ilgili kavramları anlamalarına istatiksel olarak anlamlı katkısı olduğu belirlenmiştir. Bununla birlikte, cinsiyet farkının kimyasal bağlar konusunu anlama ve Fen ve Teknoloji dersine yönelik tutuma bir etkisinin olmadığı saptanmıştır.

ANAHTAR SÖZCÜKLER: Kavram Yanılgısı, Kavramsal Değişim Metinleri, Analoji, Geleneksel Yöntem, Kimyasal Bağlar, Fen ve Teknoloji Dersi Tutum Ölçeği, Bilimsel İşlem Becerisi.

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CCIA	: Conceptual Change Instruction Analogy
TDSI	: Traditionally Designed Science Instruction
CBCT	: Chemical Bonding Concept Test
ASTS	: Attitude Scale Towards Science as a School Subject
SPST	: Science Process Skill Test
df	: Degrees of freedom
SS	: Sum of squares
MS	: Mean square
$\overline{X}$	: Mean of the sample
P	: Significance level
F	: F statistic

CHAPTER I

INTRODUCTION

Science education is the base of producing knowledge about the world. Scientists try to develop new technological tools in order to facilitate our lives or teachers try to teach science to the children or engineers try to develop technological instruments. While scientists develop new technological tools, teachers teach science or engineers develop tools, they bring their pre knowledge about the science issues. So that reason, it is very important to teach science effectively. Learning is cumulative and dynamic process. All new knowledge is added on previous knowledge of the students. There is an interaction between the new knowledge and existing knowledge. From this perpective, knowledge is seen as a product of this constructivist activity, and it cannot be simply transferred from teacher to learner; each individual is considered to build up new knowledge in his/her own mind (von Glasersfeld, 1993; Taber & Watts, 1997). Ausubel (1968) stated that the most important factor that affecting the learning is what the learner already knows. So, it should be ascertain this knowledge and then should be continue teaching.

David Ausubel (1968; Ausubel & Robinson, 1969) also developed a cognitive theory of meaningful reception learning. Meaningful learning refers to the learning of ideas, conceptions and principals related with new information to knowledge in memory. Learning is meaningful when the learners' existing knowledge interacts with the new learning in a nonarbitrary and substantive way. In the learning process, students organize new knowledge by using their experiences, mental structures, their abilities and beliefs, by this way they construct the new knowledge (Osborne & Wittrock, 1983; Nakhleh, 1992; Osborne & Freyberg, 1996). West and Fensham (1974) stated that meaningful learning occurs when the learner's prior knowledge interacts with the new knowledge and on the contrary the rote learning occurs when there is no interaction between this knowledge.

Several researches showed that students have a lot of preexisting conceptions about the topics in science. Students' minds are not empty boxes that the teachers fill with the knowledge. When students enter the classroom, they have a lot of notions, beliefs and ideas about the scientific phenomena. They use these informal ideas in order to make sense the world and they will use their pre knowledge during in all their lives (Osborne, Bell and Gilbert, 1983; Nakleh, 1992; Wandersee, Mintzes and Novak, 1994). These informal ideas have been described and named in different ways as "preconceptions" (Novak, 1977), "alternative conceptions" (Driver and Easley 1978; Driver and Erickson, 1983; Hewson and Hewson, 1989), Nakhleh, 1992; Palmer, 2001); "misconceptions", ((Helm, 1980; Fisher, 1985; Cho, Kahle, and Nordland, 1985; Griffiths and Grant, 1985; Novick& Nussbaum, 1982; Nakleh, 1992), "children's science" (Gilbert, Osborne, and Fenshman, 1982), "intuitive beliefs" (McCloskey, 1983).

Misconceptions have negative effect in meaningful learning process. Teacher must determine students' misconceptions and find out to prevent them from occurring. Researchers who studied on misconceptions found that misconceptions may arise prior to formal instruction (Strauss, 1981) or as a result of interactions with teachers (Gilbert and Zylberstajn, 1985) or from textbooks (Cho et al., 1985). These findings are important because if the teachers take the sources of misconceptions into account, they can remove these misconceptions.

Many science courses include abstract and complex concepts. One of them is chemistry. It has a lot of abstract concepts and students have difficulties understanding and learning of them. These concepts are important because further science concepts or theories cannot be easily understood if these underpinning concepts are not sufficiently understood by the learners (Nakhleh, 1992; Ayas & Demirbaş, 1997; Coll & Treagust, 2001; Nicoll, 2001). Gabel (1999) stated that students find chemistry difficult to learn if the teachers are not used analogies or models in their instruction. Chiu, (2005) claimed that if the symbols, terminologies or theories which used in chemistry are nor transformed appropriate instructional language or materials taught by their teacher into meaningful representation, students have difficulties understanding of these symbols, terminologies or theories. It is difficult for students to change their ideas about the related topic. Nakhleh (1992) claimed that most of the students have difficulties in conceptual understanding of chemistry. These students are unsuccessful in exams, in spite of working hard to the chemistry exams. Most of the students can not make a connection the real life with the chemistry taught during conventional lecturing. As a result of this they can not success in exams which include conceptual understanding of chemistry. Students have difficulties while interpreting the chemical phenomena at molecular level. In chemistry, there are many studies which focus on misconceptions related to particulate nature of matter (Novick and Nussbaum, 1981; Griffiths and Preston, 1992), mole concept (Stave and Lumpe, 1995; Yalçınalp, Geban and Özkan, 1995), electrochemistry (Garnet and Treagust, 1992), chemical equilibrium (Banjeree, 1991), chemical equations (Yarroch 1985). Chemical bonding theories and models have a important role in other topics taught in chemistry curricula. Chemical bonding is also one of the most difficult topics for students to learn at a sub-microscopic level, many students still lack a deep conceptual understanding even after traditional chemistry instruction (Bodner, 1991; Nakhleh, 1992; Herron, 1996; Teichert & Stacy, 2002; Ozmen, 2004).

Chemical bonding concept is an abstract topic where students have difficulties, for example, how students could understand topics such as reactivity, spectroscopy and organic chemistry unless they are introduced and taught theories of chemical bonding (Taber & Coll, 2002; (Teichert & Stacy, 2002). Students thought that chemical bonding concepts are abstract and students have difficulties to see and to understand an atom or interactions between atoms or other elementary particles (Griffiths & Preston, 1999). Chemical bonding theories thus are the cognitive keys that students need to be able to visualize the microscopic world of chemistry. In the literature, there many studies which focus on misconceptions related to chemical bonding (Peterson, Treagust and Garnett, 1989; Harrison and Treagust, 2000; Nicoll, 2001). Understanding chemical bonds requires understanding the matter at molecular level. To understand chemical bonding and their properties it is important to understand the atom, molecule, metals and nonmetals. Therefore, students' prior knowledge chemical bonding is important for further understanding of the chemistry concept.

Consequently, many researchers investigated how students change their informal ideas to scientific concept (Novick and Nussbaum, 1981; Griffiths and Preston, 1992). In order to develop students' understanding of the scientific concepts, it should be used effective instructional approaches. That instruction should facilitate the transformation of the prior knowledge to scientific knowledge. From this aspect, conceptual change and constructivist teaching approaches are seem to be affecting learning in positive way. Critical thinking and meaningful understanding can be enhanced by using these teaching approaches.

After 1980's constructivist researchers have been explored students' misconceptions or existing knowledge in learning natural science. After constructivist approach, many studies have been done in order to identify students' conceptions. Several models of learning in science based on constructivist approach such as learning cycle approach (Stepans, Dyvhe and Beiswenger, 1988), inquiry approach (Marten-Hansen, 2002), conceptual change model (Posner et al., 1982) and bridging analogies approach (Brown and Clement, 1989). Most of the researches showed that teaching strategies affect the students' understanding of the science concepts. The study which have done by Bodner in 1992 stated that traditional teacher centered instruction effects students achievement negatively and effects students' interest negatively.

Some constructivist researchers have chosen the use of conceptual change approaches in science education (Hewson and Hewson, 1988; Maria and MacGinite, 1987; Chambers and Andre, 1997). Pines and West (1986) also gave the big importance to conceptual change to deal with the students' misconceptions. They suggested that conceptual learning occurs when learners make their own sense about knowledge. The conceptual change model is developed by Posner in 1982. The base of this model is constructivist theory. Researchers have suggested that human learning is constructed; learners build new knowledge on previous knowledge. This view of learning is called constructivism. According to constructivist learning theory if the students construct their own knowledge actively, their understanding will be enhance comparatively passively learning (Posner, Strike Hewson and Gertzog, 1982). According to conceptual change model, learning occurs when the new knowledge constructed by the students. There are some conditions that affecting the conceptual change (Posner, Strike, Hewson and Gertzog, 1982). These are:

1. Students must be dissatisfied with prior knowledge.
2. New conception must be finding intelligible by the students.
3. The new conception must be plausible.
4. The new conception must be fruitful.

When students accomplish conceptual change in their mind, they demonstrate thinking that moves them toward accepted scientific knowledge and ability to use these understanding to describe, explain and predict real world phenomena. The best way for students to acquire the rich conceptual structures of scientific knowledge is constructing the knowledge on their own (Nakleh, 1992).

Students' informal ideas about the scientific phenomena affect the meaningful understanding of scientific conceptions taught in schools. Also, they affect the assimilation of new learning in a negative way (Hewson and Hewson, 1983). There are several things that help to construct these informal ideas in students' mind. One of them is textbooks. These are leading to construction these ideas (Cho, Kahle and Nordland, 1985). Also students' interactions with their social and physical environment affect their informal ideas (Straus, 1981) and interactions with their teachers can lead to informal ideas (Gilbert and Zylberstajn, 1985).

Students' informal ideas can be changed by using conceptual change discussions. The research studies showed that oral discussions in the class develop students' meaningful understanding and critical thinking (Hogan, Nastasi and Pressley, 2000). Also, conceptual change discussions decrease the students' misconceptions (Eryılmaz, 2002). When students accomplish conceptual change, scientific understanding occurs in their mind and describing, explaining the scientific concepts can be done easily by the students. Walton (2002) stated that the use of demonstrations and analogies in conceptual change texts enhances the understanding of scientific concept. Also, students' interest can be keep during the lesson. Use of analogy is another strategy that changing misconceptions in science content. Analogies help to students understanding difficult scientific concepts. Analogy is a cognitive process of transferring information from a particular subject to another particular subject. Analogy refers to comparison between two different things in order to highlight some point of similarity. Duit (1991) stated that by using analogies the new information may be more concrete and imaging it may be easier. Learning is an active process and students' previous acquired knowledge is important. Learning has to do with constructing similarities between the new knowledge and the prior knowledge. Thus, analogies have an important role in constructivist learning approach. Analogies support learning only specific areas of a target domain. They facilitate the students' learning process on the grounds of knowledge that is already available. Many researchers claimed that analogies are the valuable tools in teaching and learning difficult scientific concepts (Webb, 1985; Brown, 1992). Similiarly, Gabel and Samuel (1986) stated that use of analogies help students to understand the chemistry problems easily. Students make connections between the analog and certain type chemistry problems. Thus, their achievement in these problems enhanced.

There are a lot of comments in the literature; the authors suggest that teachers should use analogies and conceptual change texts when teaching bonding theories. The conceptual change oriented instruction accompanied with by analogies used in this study was to enhance the students' understanding of chemical bond concepts and reduce the misconceptions related these concepts.

Students' attitude towards science is an important issue. Because it is affect the students' achievement in science. Students' attitudes, feelings and perceptions of science are important for science achievement. There are many studies about the type of instruction affected students' interest, motivation and success in science (Chambers and Andre, 1997; Parker, 2000; Chang, 2002; Harrison and Treagust, 2000). The effect of treatment on students' attitudes towards Science and Technology in eight grade students also was investigated in this study.

There some other factors that affecting students' achievment and understanding. In the science education literature, many researchers focused on identifying cognitive variables that affect students' achievement and their understanding of science concepts such as science process skills (Lawson, 1983; Niaz and Lawson, 1985; BouJaodue, 1992; Noh and Scharman, 1997). Science process skills involve identifying variables and hypotheses, designing investigations, graphing and exploring data, explaining results and drawing conclusions. In this study, the contribution of students' science process skills to their understanding of chemical bonding concepts was examined.

In this study, the conceptual change oriented instruction accompanied with by analogies was used to correct misconceptions related to chemical bond. Conceptual change text was used in order to identify them. Also the effects of gender difference were investigated with respect to students understanding of chemical bond concepts. The effect of instruction on students' attitudes was also determined.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

Previous studies that have produced theoretical and empirical background for this study are presented in this study.

Researchers stated many aspects on teaching and learning chemistry effectively. There are many variables that affecting the students' achievement in chemistry. However, most of the studies focus on learning and teaching chemistry conceptually and most of the researchers give extra importance to conceptually understanding of chemistry in education (Harrison and Treagust, 2000; Nakleh, 1992; Teichert and Stacy, 2002; Boo, 1998). Many research studies investigated students' conceptions before instructions and change of these conceptions during the instructions. Students' conceptions that hold before the instructions is called preconceptions but misconceptions were identified as conceptions formed after the instruction.

Learning scientific concepts meaningfully is the main goal of the science education. Particularly, meaningful learning is important for students to understand the chemical concepts. Because of the abstract nature of the chemistry concept student's understanding of them is difficult. If the students relate the previous knowledge that already learned with the new knowledge, learning new knowledge will be meaningful. Therefore, learning in science is reinstruction of existing ideas not adding information to prior knowledge (Hackling and Garnett, 1985). In order to develop scientific understanding in students, teacher must know the depth and tenacity of the student's pre-existing knowledge. To enhance students' understanding of scienctific concepts, teachers need to select science content and design learning environments in terms of their students' interests, knowledge, understanding, abilities and experiences (Carey, 1986). Activities and examples in the instructions will be enhancing the meaningful learning in students' mind. Before the instruction, teachers make discussions about the new concept, they will recognize students' ideas about the new concepts and also by this way students become be aware of their thinking. Also, when the teachers were planning the instruction, they must to be aware of and understand common alternative conceptions of science at a given educational level, as well as the other influences on learning (Unal at al. 2006).

Chemical bonding concepts is fundamental part of chemistry. Taber and Coll (2002) stated that students have problems in understanding topics such as reactivity, spectroscopy and organic chemistry unless they are taught the theories of chemical bonding. Chemical bonding concepts are abstract bacause; students cannot see an atom or interactions between atoms or other elementary particles (Griffiths & Preston, 1999). Because of the abstract nature of this concept, students are faced with difficulties and also they have some misconceptions about the chemical bonding. For this reason, it is important to define and describe these misconceptions, also to explain special instructional strategies to eliminate these misconceptions. Therefore this study is concerned with students' alternative conceptions about the chemical bond and the effect of conceptual change based instruction on understanding of chemical bond concepts.

On this ground the literature were examined with respect to conceptual understanding of science, students' conceptions in science, misconceptions and students' misconceptions in chemical bonds, conceptual change approach, analogy and students' attitude and its relation with achievement.

2.1 Studies Related to Conceptual Understanding of Chemistry

Science education tries to to make students acquire scientific knowledge. Knowledge is continuously developing in complexity. People transform meanings to conform to their own versions of knowledge. So, meaning is seen as an end product of cognitive ability. Meanings are enhanced, extended or deleted as the individual interacts with more complex situations. Piaget (1950) believed that acquisition of knowledge is a process of self construction. A learner discovers knowledge and as the learner develops and interacts with the environment, he continues to invent knowledge.

Learning occurs when the learners is involved in construction of meaning actively. Piaget (1950) stated that if a person's intellectual capacity develops, the importance of the metaphysical aspects of conceptual change will increase. As a result, the age of a person must be relevant to a conceptual change process. Piaget also considered three processes important in cognitive development: assimilation, accommodation and equilibration. If a child uses existing concepts to deal with new phenomena, this is called assimilation. When the students' current concepts are inadequate to allow him to grasp new phenomenon, then he replaces or reorganizes his central concepts. This is called accommodation. Equilibrium, determines the child's transition from one stage of development to the next. At each stage, at the beginning, the child uses his logical structure that work well but toward the end of the stage, he becomes dissatisfied with his structure, organizes it and attains a new equilibrium. According to Piaget, equilibrium encompasses both assimilation and accommodation.

On the other hand, Vygotsky (as cited in Steffe and Gale, 1995) dealt with mechanism of development to the exclusion of distinguishable developmental stages. He rejected that Piaget's equilibration stage. He claimed that development is more complex. Vygotsky focused on process rather than product, his interest was not how well the children perform, but what they did under varying task conditions. Cultural and social factors affect the development of intelligence. Unlike Piaget, Vygotsky focused on social activity. Development is transformation social relations to mental operations.

Vygotsky claimed that learning and development are separate. Each school subject has its own relation to the child development and it varies as the child goes one stage from another. As well as prerequisite skills and knowledge within a discipline, solving problems that enable them to improve their skills is important. Learning is more than acquisition of thinking ability; it is acquisition of many specialized abilities for thinking and occurs through social interactions. Partners work together and co-construct the solution to a problem.

David Ausubel also supported a cognitive approach to learning. However, his ideas differed from Piaget’s ideas in that Ausubel focused on conceptual rather than operative forms of knowledge. He was one of the first researchers to study the connection between meaning and learning. He stated that in order to create meaningful learning, students must make a relation between new knowledge and existing knowledge in their cognitive structure. For this reason, Ausubel (1968) said that, "The most important single factor influencing learning is what the learner already knows”. This idea of Ausubel has been the guide to many science education researchers and their studies (i.e., Novak, 1993). These studies have consistently shown that students do not come to classroom with blank slates (Posner, Strike, Hewson and Gertzag, 1982). In fact, students from the moment of birth infants need to make sense of their world. They construct their own explanations for how and why things behave as they do. So, long before they begin formal schooling, children have made meaning of their everyday experiences. And, they will construct new knowledge on their previous conceptions. Ausubel (1968) has labeled these conceptions as “preconceptions”. Learning process is constructed by the students. Students existing ideas, knowledge and experiences affects the learning process, so they are very important. Learning occurs by changing students’ existing knowledge and adding new knowledge. This view was developed as a conceptual change by Posner, Strike, Hewson and Gertzog (1982). They claimed that if the new knowledge and the prior knowledge have an interaction, learning occurs. Students’ prior knowledge must be restructured or even exchanged for the new knowledge. The construction and reconstruction of meanings by students’ needs that they actively seek to integrate new knowledge with the existing knowledge (Novak, 2002). So, meaningful leaming involves students in constructing integrated knowledge structures. These structures contain their existing knowledge, experiences, new knowledge, and other related knowledge (Tsai, 2000).

Most of the studies in science education show that students have some troubles in understanding of some basic chemistry concepts (Çalık, Ayaz 2004; Boo, 1998; Nakleh, 1992). Students find chemistry difficult to learn because conceptions in chemistry are abstract and inexplicable without the use of analogies or models

(Gabel, 1999). Most of the topics in chemistry are far removed from the daily experiences of junior high school students. So that reason, many students have difficulty in understanding of these abstract concepts.

Carey (1986) stated that we cannot develop students' scientific understanding without knowing the depth and tenacity of their prior knowledge. In order to enhance students' understanding of science concepts, teachers must be careful while selecting science content and designing learning environments. Teachers consider their students' interests, knowledge, understanding, abilities and experiences while designing the lesson. Also teachers must to be aware of and understand common alternative conceptions of science at a given educational level, as well as the other influences on learning while they are planning the instruction.

There are several studies about the conceptual understanding of chemistry. Harrison and Treagust (2000) studied on students' intellectual models on atoms, molecules and chemical bonding. Students' intellectual models about these concepts are different from the accepted models. The researchers claimed that text books and models that teachers used are affected students' construction of these intellectual models. In order to develop conceptual understanding we can use models, analogies, concept mapping, conceptual change texts. These tools help to students construct the new knowledge by using their existing knowledge and experiences. Similar results are founded by Çakır, Uzuntiryaki and Geban (2002). They studied the effects of concept mapping and conceptual change texts instruction over the traditional instruction on tenth grade students understanding of asid and base concepts. 110 students participated to the study. Six classes were chosen and conceptual change text instruction was used in two of them, concept mapping instruction was used in two of them and traditionally instruction was used in other two of them. Pre test and post test were administered to the classes. As a result of the study they found that conceptual change text and concept mapping enhanced the conceptual understanding comparatively traditionally instruction.

2.2 Students' Conceptions in Science

There are a lot of studies related to students' informal ideas about the scientific phenomena (Driver and Easley, 1978; Osborne, Bell and Gilbert, 1983; Eylonn and Lynn, 1988). These research studies identified that students develop some informal ideas which make sense of the world around them. They construct these ideas through their experiences with their environment. The researchers described ad named these informal ideas in different ways as preconceptions, misconceptions, alternative frameworks (Driver and Easley, 1978), children's science (Gilbert, Osborne, Fensham, 1982), alternative conceptions (Hewson and Hewson, 1989), intuitive beliefs (McCloskey, 1983), naive beliefs (Caramaza, McCloskey and Green, 1981) and spontaneous reasoning (Viennot, 1979).

Students' personal experiences with the natural events and their environment cause their personal interpretation. Students make sense of these experiences for themselves before the instruction. Driver and Easley, (1978) proposed the term of alternative framework to indicate these interpretations. Additionally, Schmidt (1997) described the term of alternative framework as opposed to the alternative conception. He stated that students' ideas can be seen as a meaningful and logical coherent alternative to the science concept. Hewson and Hewson, (1989) described that the term of alternative conceptions as a conception that contradictory or inconsistent with the new concept. Usually, alternative conception contains more than one concept.

Children have prior ideas before the science teaching. They have some beliefs about how things happen and they bring with them to the science classes. These views affect their science learning. Children science term is indicated that children' idea formed before the science teaching (Gilbert, Osborne, Fensham, 1982). They researched that children's science and its consequences for science. They stated that three assumptions related to ways of interactions of students' ideas with classroom interactions. First assumption is students enter classroom with little or no knowledge related to content of instruction. The second assumption is students' ideas can be displaced easily by using effective instruction. Teachers' role is important in this assumption. According to third assumption students' ideas are resistant to change with the new knowledge. The interaction between their knowledge and the new knowledge may yield a lot of different outcomes. For example; students retain their idea intact; students retrieve both their concepts and new concepts which learned in the school or they make a synthesis between the two.

The term of misconception is different from the alternative frameworks. Misconceptions occur when the students incorrectly assimilate the models or theories (Driver and Easley, 1978). According to Ausubel's theory, students make a relation between the new knowledge and the existing knowledge. If the cognitive structures holds incorrect conceptions, these incorrect conceptions interfere with learning process. Misconceptions result from the interaction between students and their environments. Misconceptions are not easily replaced with the correct mental models. Correcting misconceptions requires that students must be aware of their misconception and dissatisfied with it. Also, a replacement concept must be found by the students intelligible, applicable and plausible. There is some source of students' misconceptions. These are school teaching (textbook, laboratory experiences, symbolic representation), outside school teaching (everyday experiences, media, language, peer interaction) and intuition (Stepans, 1991; Herron, 1996). One of the misconceptions source is teachers (Roehring, 2005). If the teacher makes the poor lesson plan and he or she is not prepared the lesson, misconceptions can be occurred the students' mind (Eckstein and Shemesh, 1993). Also, teachers may have misconceptions and they may use these misconceptions in their instruction. Kruse and Roehring, (2005) studied on teachers. They asked 22 questions in a teacher professional development workshop and they found that more than half of the teachers chose incorrect response. Consequently, they stated that most of the students' misconceptions are parallel with those of teachers.

Research studies have reported that misconceptions or preconceptions of the students are resistant to change by traditional method of instruction (Duschl and Drew, 1991; Wong and Pungh, 2001). If students already have some preconceptions which contradict with the scientific phenomena, it is difficult to change these ideas with the scientific ideas. If the new knowledge can not fit the students' prior knowledge, assimilation of new knowledge and learning process can be inhibited (Hewson and Hewson, 1991).

Researchers named students' ideas in different ways. It is not important how they are named, the important things that consequences of students' conceptions. Duit (1991) summarized how can be prevent these ideas as following:

- To change the content structure of instruction can avoid misunderstanding.
- New teaching tools may help to overcome difficulties.
- To change teaching strategies may help to overcome the misunderstanding
- Meta-learning strategies may help to students' understanding.
- If the teachers learn the constructivist ideas and used these ideas in their lectures, students learning can be enhanced.

2.3 Misconceptions

A number of studies have been conducted over the last twenty years to probe students' misconceptions in the subject (Gabel, 1989; Nakhleh, 1992; Wandersee, et al., 1994; Garnett & Hackling, 1995; Taber, 2002; Ozmen, 2004) Misconceptions result from the interactions between the students and their environment. Most of the misconceptions are difficult to change. There are some sources that affecting student' misconceptions. These are school teaching, outside school teaching, everyday experiences, social environment and intuition (Stepans 1991; Herron 1996).

Fisher (1985) defined the characteristic of misconceptions. These are; misconceptions are resistant to change, persistent, well embedded in an individual's cognitive ecology, and difficult to extinguish even with instructiondesigned to address them. When the literature with misconceptions examined it was seen that different types of misconceptions. Riche (2000) has categorized misconceptions into four types: These are preconceived notions, factual misconceptions, vernacular misconceptions and conceptual misunderstandings.

Preconceived notions or preconceptions are derived from students' everyday experiences. These are very common. Students' relation with environment and non formal explanations of their surroundings affects the preconceived notions or preconceptions (Marioni, 1989). For example, some people believed that a moving object slowed down because the driving force to push or pull the objects was gradually being used up. There are many other preconceived notions that the students have, for example, in learning atom and molecule (Nakleh, 1992) ; heat, energy, and gravity (Brown & Clement, 1991).

The second type misconcepitons are factual misconceptions. These are untrue assertions often learned in childhood and kept unchallenged into adulthood. Forexample, "lightning never strikes twice in the same place" is absulately wrong, but many people may still believe it is true (Terry et al., 1985; Dykstra, et al., 1992).

Vernacular misconceptions are derived from the use of words that mean one thing in everyday life and another in a scientific context. Some words of scientific means and every day means are different. By this way, vernacular misconceptions ocur in students' mind. For example, scientific means of “melt" is"solid changes to liquid at its melting point" but in everyday life means of "melt" is often used for "dissolve." You can often hear people say that chocolate melts in the mouth or sugar melts in the tea or coffee when it is actually dissolving (Blanco at al. 1997).

Conceptual misunderstandings derived from when students are taught the scientific new information that contradicts their preconceptions and non-scientific beliefs (Ivowi and Oludotun, 1987). In order to deal with this confusion, students often construct incorrect models or hold weak understanding. For example, students always confuse the tempature and heat. They believe that temperature is a form of energy but temperature is not energy. It is the measure of average kinetic energy of the molecules.

Comittee of Undergrade Science Education (1990) catagorized students' misconceptions according to their source.

1. Concepts of depending of preconceptions: These are the most seen misconceptions in daily life. For example, students think that under grade water are similar with the river.
2. Nonscientific ideas: Students learn some scientific concepts by the means of religious knowledge.
3. Conceptual misconceptions: Students interfere the concepts wrongly
4. Distrinct misconceptions: Sometimes, The words that used in daily life and the words that used science are different. So, students can not link them and misconceptions occur.
5. Misconceptions depending of truth: These misconceptions are learned in early childhood and to change these misconceptions is difficult.

The areas of chemistry investigated misconceptions in many concepts. For example, atoms and molecules (Griffiths & Preston, 1992; Harrison & Treagust, 2000), element, compound, and mixture (Ayas & Demirbas, 1997), solubility and solutions (Longden, 1991; Ebenezer & Erickson, 1996; Ebenezer & Fraser, 2001), chemical reactions (Andersson, 1990; Boo & Watson, 2001; Ayas & Ozmen, 2002; Ozmen & Ayas, 2003), acids and bases chemistry (Bradley, 1998; Sisovic & Bojovic, 2000), mole (Gabel & Sherwood, 1984; Schmidt, 1994), chemical bonding (Peterson, et al., 1986; Taber, 1993; Boo, 1998; Robinson, 1998; Tan & Treagust, 1999; Coll & Treagust, 2001; Nicoll, 2001; Coll & Taylor, 2002; Coll & Treagust, 2002; Coll &Treagust, 2003; Ozmen, 2004).

2.4 Students' Misconceptions with Chemical Bond

Chemical bonding is one of the basic topics in chemistry. Since it is an abstract concept which can not be applied to everyday life directly, many students aren't able to comprehend this concept. They cannot relate microscopic world to macroscopic world. In addition, understanding chemical bonding requires some physics topics such as energy and force in which students have difficulty in understanding. As a result, they hold many misconceptions related to chemical bonding concepts. Studies related to students' understanding of chemical bonding showed that students had a lot of misconceptions in several grade levels. Also, these misconceptions are resistant to change by traditional teaching methods because knowledge and information transmission occur in traditional teaching methods.

Gillespie (1997) addressed that the fundamental ideas of chemistry are atom, molecule and ion; second one is chemical bond; third one is molecular shape and geometry; fourth one is kinetic theory; fifth one is chemical reaction; sixth one is energy and entropy. These topics are base of the chemistry. According to Gillespie, atom, molecule and ion are buildings of the matter and all chemical bonds are occurred by the electrostatic force of the positive nucleus and negative electrons. Electrostatic force is one of the most important issues in chemistry. To understand the concept of the orbital is difficult for the students. Chemical bonds can be explained only using electrostatic force for the low level students. Concept of the hibrit orbital is not necessary while explaining the molecular shape. The VSEPR (Valence Shell Electron Pair Repulsion) model is the simplest model for the students. Also, (Boo, 1998) stated that the concept of chemical bond is fundamental part of the chemistry. Meanwhile students have many difficulties to understand this issue. According to Fenshaw (1975), chemical bonding is applying to all chemical systems, so this concept is very important. For example, it is essential to comprehend the nature of thermodynamics, molecular structure, chemical equilibrium, chemical reactions and some physical properties such as boiling points. Also, Taber Coll, (2002) stated that similar approach. They said that as the breaking and forming of chemical bonds is used to explain chemical reactions, chemical bonding is a key concept in chemistry. Chemical bonds that affect them are important concepts in basic chemical curriculum. There are several studies on students’ understanding of chemical bonding and their misconceptions in the literature.

Several studies indicate that students have many misconceptions about chemical bonding and studies focused on these perspectives: investigation of, and changing, student alternative conceptions on chemical bond at various educational levels

(Peterson *et al.*, 1989; Tan, and Treagust, 1999; Coll & Treagust, 2001; Nicoll, 2001; Coll and Taylor, 2002; Ozmen, 2004; Ünal *et al.*, 2009), ionic bonding (Butts and Smith 1987; Taber, 1997; Robinson, 1998; Coll & Treagust, 2001; Coll & Treagust, 2003)), covalent bonding (Treagust, 1988; Peterson & Treagust, 1989; Griffiths, 1994; Boo, 1998; Tan & Treagust, 1999; Coll & Treagust, 2001), chemical bonds and energetics (Barker, 1995; Boo, 1998; Barker & Millar, 2000; Boo & Watson, 2001), molecules and intermolecular forces (Treagust, 1988; Peterson & Treagust, 1989; Garnett & Hackling, 1995; Boo, 1998; Birk & Kurtz, 1999; Tan & Treagust, 1999), use of anthropomorphic language and analogies (Harrison & Treagust, 2000; Coll & Treagust, 2001; Nicoll, 2001).

Staver and Halsted (1985) explored the effect of students' logical thinking ability, use of model and gender difference on student's success of the chemical bonds concept. They studied with 84 students in Chicago. Students are separated to Experimental and control groups. In experimental group, models are used in instruction. In control group traditional method is used. The study showed that there is a effect of students' logically thinking ability on students' success. But there is no effect gender difference and use of model on students' success. Also, interaction of them are effected the students' success on chemical bonds.

Explanations in textbooks cause misinterpretation. Posada (1997) explored the fifty-eight Spanish high school chemistry textbook from 1974-1998 in order to analyze the treatment of metallic bonding. He used a questionnaire. 12 items was used in the questionnaire. He explored what is usually taught, how it is taught and how the textbook provide the meaningful learning. Result of the study showed that most of the textbook explained that Metallic bonding model defined as the relationship among models and experimental facts can not be understood by the students. Textbooks' explanation is metaphorical for students and these explanations cause misinterpretation. Also, characteristic of the theoretical models are not explained clearly. There is lack of integrative reconciliation among different topics.

Students have difficulty in understanding why and how bonding occurs. This point was summarized by Butts and Smith (1987). They researched that chemistry students' understanding of the structure and properties of molecular and ionic compounds. The study showed that students were confused about ionic and covalent bonds and structures. They studied with 26 grade-12 students. 10 of them referred to molecules in solid sodium chloride; some also conceptualized the sodium and chlorine atoms as being held together by covalent bonds. Only four students demonstrated a clear understanding of the three-dimensional lattice structure of sodium chloride. Similar confusions were reported by Taber (1994) for Grade 11 subjects. He stated that students acquire this idea because they do not "share the framework of electrostatics knowledge" of the teacher, and also because they are taught about the formation of ionic bonds in a way which promotes the molecular model.

Robinson (1998), reviewed many researches related to students' ideas on chemical bonds and understanding of chemical bonds. He proposed the students' alternate frameworks related the chemical bond as following:

- Chemical bonds form in order to produce filled shells rather than filled shells being the consequence of the formation of many covalent bonds.
- Atoms need to fill the shells (an anthropomorphic idea).
- A covalent bond holds atoms together because the bond occurs by sharing electrons.
- Molecules form from isolated atoms.
- There are only two kinds of bonds: covalent bonds and ionic bonds. Anything else is just a force, "not a proper bond".
- Ionic bonds occur by the transfer of electrons, rather than the attractions of the ions that result from the transfer of electrons. The reason electrons are transferred is to achieve a full shell.
- An ionic bond only occurs between the atoms involved in the electron transfer. Thus, sodium ion forms one ionic bond to a chloride ion in solid sodium chloride and is involved in five "forces" with the other adjacent chloride ions.

- Na+ and other ions are stable because they have a filled outer shell.

Birkt and Kurtz (1999) studied on students' misconceptions on covalent bonding. They studied with different level students. The result of the study showed that high level students have less misconception than the others. Some of the misconceptions that the students have are:

- Molecular shape is constituted by the push of the electrons.
- In all covalent bond type electron couples are shared equally.
- If a molecule have polar bond, it is polar.
- Apolar molecules occur when the atoms have same electronegativitiy.

Harrison and Treagust (2000) studied on students' learning about atoms, molecules and chemical bonding by using multiple models in grade 11 chemistry students. The researchers made a year long case study and ten students administered to the study. As a result of the study researchers suggest that students who socially negotiated the common analogical models for atoms, molecules and chemical bonds made good explanations about these topics. Also they claimed that when the teachers give the analogical models in a systematic way, students' understanding of these abstract concepts can be enhanced.

Uzuntiryaki (2003) explored the effects of constructivist teaching approach on students' understanding of chemical bonding concepts and attitudes toward chemistry as a school subject. As a result of the study, the instruction based on constructivist approach had a positive effect on students' understanding of chemical bonding concepts and have significantly positive attitudes toward chemistry as a school subject than the traditionally designed chemistry instruction.

Sevim (2007) explored science student teachers' alternative concepts within basic concepts of solutions and chemical bonds and the efficiency of conceptual change texts. The sample of this study consists of 150 first year student teachers who attended "Chemistry" courses taught by two lecturers in three classrooms at the Middle School Department of Science Education in Fatih Faculty of Education in

KTU. The quasiexperimental research design was used in this study. Two classes were randomly selected as experimental groups and the other was selected as a control group. In the study, data was collected by using Chemical Bonds Concept Achievement Test, Solution Chemistry Concept Achievement Test Cognitive Process Skill Test, Attitude Scale Towards Chemistry as a School Subject and student teachers' interviews. After the implementation, the students' scores on the posttests and delayed posttests showed that the experimental group, at which conceptual change texts were used before instruction, scored significantly higher than the control group and the experimental group, at which conceptual change texts were used after instruction, with respect to achievement related to chemical bond and solution concepts. At the same time, it was elicited that there was a clear difference between experimental and control groups as to attitudes toward Chemistry.

Similiar study has done by Baykan (2008). She evaluates the level of understanding and misconceptions of chemistry and science student teachers and eleven grade students about the topic of Chemical Bonding. The developmental research approach, which enables a synchronous and less-timeconsuming study of equivalent samples, is used in this study. The data is collected by means of a test and interviews. The test used in the research is a two-tier diagnosis test which decreases the negativities of multiple choice tests to the minimum and enables the determination of misconceptions with their reasons. The questions of the test are set by using the related studies in the literature area and misconceptions which are found out. The developed test has been applied to 31 eleventh grade students, 69 student teachers of chemistry and 82 student teachers of science. Besides, individual interviews have been conducted with six chemistry student teachers, six science student teachers and three eleven grade students. The result of the study showed that there is a statistically significant difference between the understandings of chemistry and science student teachers and grade eleven students concerning chemical bonding. In other words, science student teachers have showed a lower achievement in comparison to both chemistry student teachers and eleven grade students. In addition, some misconceptions of student teachers and eleven grade students, which are not listed in the literature, are determined. Some of the misconceptions that the researcher found:

- Hydrojen act like metal with nonmetal, thus thay make ionic bond.
- Atoms make chemical bonds because they want to diminish their electrostatic force.
- Metal and nonmetal make metalic bond by sharing electron.
- Ionic and covalent compounds have Van Der Waals force.
- Number of atoms in molecule define the polarity of molecule.

Ünal, Çalık, Ayas and Coll (2006) explored on students' conceptions and their general knowledge and misconceptions on chemical bonds. In order to achive this they developed a matrix by using related literature. The matrix includes that student' aims and needs, misconceptions, methods of exploring students' conceptions, general knowledge, implications and recommendations for teaching and learning, implication of curriculum development. In this study, they investigated students' misconceptions and level of education, understanding of ionic bonding and metallic bonding, understanding of intermolecular forces, students' use of anthropornorphic language and analogies, students' mental models for chemical bonding and enhancing students' conceptual understanding.

Atasoy,B, Kadayıfçı H. and Akkuş H. (2003) studied on chemical bonding concept and they compared the effects of constructivist approach and traditional instruction on the students' understanding of the topics. They explored Lyceum third students' misconceptions. Students are seprated into Control and experimental group. In experimental group, constructivist approach was used and in control group traditional instruction was used. Pre test and post test was conducted to the students. After the application, the researchers interviewed with thirteen students. Result of the study showed that students have some misconceptions about the ionic and covalent bond, bond polarity, shape of molecule and orbital concept.

Peterson et al. (1989) investigated Grade-11 and Grade-12 students' misconceptions of covalent bonding and structure. This diagnostic instrument was composed of 15 two-tier multiple-choice items. The treatment test is condusted in two stages. In order to find students' content knowledge related to chemical bond multiple choice questions were asked to the students in the first stage of the treatment. In the first stage, each item consists of a content question having two, three, or four possible reasons for the answer given in the first stage, which included the correct answer and three alternatives reasons involving misconceptions. The alternative reasons and misconceptions were identified from unstructured interviews, students' concept maps and open-ended pencil-and-paper test items. The questions in the test are related to bond polarity, shape of molecules, polarity of molecules, octet rule. This test was administered to 223 high school students. The following misconceptions that students hold were stated as follows:

- Equal sharing of electron pairs occurred in all covalent bonds.
- Nonpolar molecules formed when the atoms in the molecule have similar electronegativies.
- Nitrogen atoms can share five electron pairs in bonding.
- The shape of a molecule only influenced by nonbonding electron pairs in a molecule.
- Intermolecular forces are molecules within a molecule.
- High viscosity of molecular solid is due to strong bonds in the covalent lattice.
- The shape of a molecule is due to equal repulsion between the bonds only.
- Covalent bonds are broken when a substance changes state.
- Ionic charge determines the polarity of the bond.
- The polarity of a bond is dependent on the number of valance electrons in each atom involved in the bond.
- Bond polarity determines the shape of a molecule.

They found that students have trouble in understanding of covalent bonding. Many students have misconceptions about electron pair in covalent bonding. Also they found misconceptions on bond polarity, molecular shape, polarity of molecules, intermolecular forces, the octet rule, and lattices.

Butts and Smith (1987) stated that students have misconceptions about covalent and ionic bonds. Some of the students thinks that sodium and chlorine atoms as being held together by covalent bonds. Boo (1998) investigated Grade 12 students' understandings of the nature of chemical bonds and energetics elicited across five familiar chemical reactions following a course of instruction. Researchers choose five reactions and then served as the framework for drawing up a semistructured interview protocol. 48 students administered to the study. He found some misconceptions about chemical bond. Some of the misconceptions that the students have are:

- Covalent bond as the result of the sharing of one electron between two atoms, not sharing two of three atoms.
- There is no concept of electronegativity difference, and to whom there seemed to be no rules governing the bonding process. They think that metals such as magnesium and copper could form covalent bonds with nonmetals such as chlorine or oxygen.
- Ionic bond and metallic bonds were "not real bonds, in the sense of covalent bonds.
- Dissolving process are not affected ionic bond, and that only weaker bonds between ionic molecules are broken in the dissolving process.
- Ionic bond was broken during the dis-solving process.

Boo stated that in every day usage of the term 'driving force', 'bond' and 'energy' are different meanings with the meaning in chemistry. So, students have difficulties in grasping these chemistry concepts and then misconceptions occur. Teachers, curriculum developers, and textbook writers must be aware of the various ways in which material presented could be misconstrued and hence be a hindrance to student learning.

Nicoll (2001) studied on undergraduates' bonding misconceptions. He described the types of misconceptions related to electronegativity, bonding, geometry, and microscopic representations. He interviewed with 56 students from six different courses, representing freshmen through senior level chemistry. Students' misconceptions related with chemical bonding were broken down into five sub-categories. These are polarity, bond confuse, general bonding, wrong bond and micro bonding. This work is also established that some students' misconceptions relating to bonding are resistant to change despite increased chemistry education.

Polarity: Students had misconceptions about polarity because of the concept of electronegativity. Most of the students defined polarity without invoking electronegativity. While students may have appeared to know about the concept of polarity, they didn't associate it at all with electronegativity.

Bond confuse: There are misconceptions on definitions of ionic and covalent bonding. For instance, they said that ionic bonding was a sharing of electrons.

General bonding: There are misconceptions in the process of bonding. This included incorrect explanations for bonding phenomena or incorrect explanations for why bonding occurs.

Wrong bond: When students were asked to explain what a chemical bond was several students brought up terms and concepts that were not examples of chemical bonding.

Micro bonding: There are misconceptions of the microscopic domain of bonding. The base of these misconceptions is students did not necessarily bring up the concept of atom, molecule, and ion. In addition, researcher stated that some students' misconceptions relating to bonding are resistant to change despite increased chemistry education.

Griffiths and Preston (1992) reported that students' thinking about properties of matter particles. They interviewed with 30 grade-12 Canadian students drawn from 10 high schools. Subjects were grouped as Academic-Science, Acadenic-Nonscience, and Nonacademic-Nonscience according to students' academic success in science. 10 students were assigned in these groups. The interview guide consisted of two parts, first one is related to atoms and second one is related to molecules. Questions in the first part were about the structure, shape, size, composition, weight, bonding and energy of water molecules. Questions in the second part were about structure, weight, shape, size and perceived animism of atoms. Researchers found that 52 misconceptions about these concepts.

Taber (1993) made interviews studies on students' misconceptions of chemical bonding and found some important misconceptions. In the first interview, the student described a sodium chloride crystal as just sodium atoms and chlorine atoms arranged in rows. In the second interview, the term "molecule" was used to describe ionic substances. In the third interview, the student still was not sure if any bonding existed in sodium chloride because she thought sodium and chloride were just mixed without combining. In another study (Taber, 1994) ten A-level chemistry students were interviewed during the first few weeks of the semester and re-interviewed as the course progressed. The data collected led Taber to formulate a "molecular framework," which students use to describe ionic bonds.

Taber (1997) studied on students' misconceptions on ionic bonding. The researcher made a small-scale survey in order to find common misconceptions of the ionic bond. He stated that many chemistry students had difficulty in understanding of ionic bonding. He identified students' misconceptions in five categories. These are:

1. Students overemphasizes the process of electron transfer,
2. Students use the notion of ion-pairs as molecules,
3. Students are constrained by consideration of valency,
4. Irrelevant electron history is misunderstood by the students.
5. Students have difficulty while making equivalent interactions between ions.

Boo (1998) studied on students' misconceptions about chemical bonding and he found several misconceptions about it. These are;

- Atoms do chemical bonds form in order to make filled shells.
- Atoms must fill the shells.
- Electron sharing occurs in covalent bond so covalent bond holds atoms together.
- Molecules form from isolated atoms.
- There are only covalent bonds and ionic bonds among the atoms. Anything else is just a force, "not a proper bond."
- Ionic bonds are the transfer of electrons.
- Element and compound are the same thing

- Bond making requires input of energy and bond breaking release energy.

In other study Taber (2000) pointed out that was a common misconception that any species with an octet or a full outer shell of electrons is stable. Taber (2003) investigated college students' mental models for bonding and structure of metals. His study strongly emphasized that students' existing knowledge influence their mental model and learning. He stated that students use their knowledge of ionic and covalent bonding while thay are explaining metallic bonding. The instruction may not provide students with appropriate prior learning. Therefore, he suggested that while teaching chemical bonding, first metallic bonding should be introduced and then ionic and covalent bonds should be taught.

Treagust and Coll (2001) investigated students' mental models of chemical bonding. The subject of the study is six learners. Two of them are (Year-12) secondary school student, undergraduate and postgraduate Australian students. In order to find out learner's mental models of chemical bonding, researchers are used semi-structured interviews comprising three-phase interview protocol. Each learner was presented with samples of metallic, ionic and covalent substances then they describe the bonding in substances. After that, they were shown prompts in the form of Interview-About-Events focus cards which are consisted depiction of models of bonding for the target system metallic bonding/ ionic bonding/covalent bonding. The study showed that students in all three academic level used simple and realistic mental models for chemical bonding and students have difficulties in understanding of chemical bonding. Also, students did not construct their own knowledge and they don't know how to link new concept with the existing concept. They need to develop their own strategies for these situations. Similar results find out in a study which is done by Richard Coll in 2007. In this study the researcher used mental models. From three educational levels, senior secondary, undergraduate and graduate 30 students participated to study. He used three step interview protocols. In the first step, common substances (table, salt etc) were shown to the participants and then asked to explain the bonding in these substances. In the second step, they were shown events depicting physical and chemical properties like conductivity and asked to use their mental models while they are explaining the event. In the third step, it was asked that which curriculum material prefer while using mental models. Data also were collected from curriculum material and interviews with faculty. The result of the identified in three target system for chemical bonding and eight target models. The result of the study showed that learners in all academic levels prefer simple and realistic mental models for chemical bonding.

Coll and Taylor (2001) studied on learner's mental models for chemical bonding. They interviewed with senior secondary students, undergraduates and postgraduates students in New Zealand. At the beginning of the study, the researchers analyzed lesson plans, textbooks, lecture notes and other related materials. Then they summarized eight mental models for chemical bonding. These are; electron sea model, band theory for metals, a model based on electron transfer, model involving the calculation of electrostatic charges for ionic substances, the octet rule, the molecular orbital theory, the valance bond approach and ligand field theory for covalent substances. The interview protocol included variety of common substances and focus cards that depicted model. The study showed that learners' mental models from all three academic levels were simple and realistic in nature, in contrast with the sophisticated and mathematically complex models they were exposed during the instruction. In advanced level students used more detailed explanations for their models. Researchers found thse misconceptions:

- Metallic lattices contain neutral atoms.
- Ionic bonding occurs by sharing of electrons.
- Metallic and ionic bondings are weak bondings.
- The bonding in metals and ionic compounds involves intermolecular bonding
- Intramolecular covalent bonding is weak bonding.
- Continuous metallic or ionic lattices are molecular in nature.

Treagust and Coll, (2002), explored secondary school students and undergraduate and graduate level learners' mental models of ionic bonding. They used interview protocol. It includes the use of physical substances and focus card which contain depiction of models of ionic bonding and the structure. They gave the secondary school students and undergraduate and graduate level learners and they analyzed the data. The result of the study showed that the secondary school students see ionic bonding as consisting of attraction oppositely charged spices that arise from the transfer of electron driven by the desire of atom to obtain octet of electron. The undergraduates see the lattice structure is the most important factor in ionic substances. The graduates explained mostly ionic lattices and they were not focus on particular ionic structures. The findings of the study are similar with the study which they had done in 2001. The study showed that learners' at all educational levels have many alternative conceptions and they have simple mental models.

Tan and Treagust (1999) studied on students' alternative conceptions related to chemical bonding. They developed a two-tier multiple choice diagnostic instrument. 14-16 year-old students participated to the study. Items were developed through interviews with students, students' concept maps, questions of past exams and personal teaching experiences. After that, it was conducted to 119 chemistry students in a secondary school. They found that most students have many misconceptions in chemical bonding concept. The researchers found these common misconceptions:

- Metals and nonmetals form molecules.
- The strength of intermolecular forces is constructing by the strength of the covalent bonds present in the molecule.
- Ionic compounds exist as molecules formed by covalent bonding.
- A metal is covalently bonded to a nonmetal to form a molecule.
- Atoms of a metal a nonmetal share electrons to form molecules.
- Metals and nonmetals have strong covalent bonds.

Robinson (1998) found that students believe that ionic bonds only occur between the atoms involved in the electron transfer. For instance, sodium ion forms only one ionic bond with a chloride ion that gains electron. Students' definitions of ionic bond were that the transfer of electrons, rather than the attractive force between oppositely charged ions resulted from the electron transfer. The reason of electron transfer was just to achieve a full outer shell. It was also found that students believe there are only two kinds of bond: either ionic or covalent bond.

On the other hand, Butts and Smith (1987) explored students' understanding of ionic bonding. They interviewed twenty-eight 17 year old Australian students about ionic bonding. They were asked to draw and then explain the structure of sodium chloride. Many students did not realize the ionic bonds are three-dimensional. Researchers stated that some students were confused between covalent and ionic bonds. They often reported that they considered sodium chloride was molecular and that sodium and chlorine atoms combined by sharing electrons. Butts and Smith asked the students to describe what would happen when sodium chloride was dissolved in water. Some students explained that the salt would react with the water to form sodium, chloride, hydrogen and hydroxide ions. Some students thought that sodium and chloride ions would still stick together.

Barker (2000) explored the students' understanding of chemical bonding and thermodynamics. She found that students have difficulties in understanding of ionic bonding cut they learn the covalent bonding more easily than the ionic bonding. Some students think that ionic bonding occurs like the covalent bonding and covalent bonding is weak than the other bond. According to literature about the understanding of chemical bonds, misconceptions that the students hold are similar in these researches. So that reason in this study I will use these misconceptions while constructing the conceptual change texts.

Some of the researchers also explored that effect of computer animaitons on understanding chemical bond. Özmen at (2009) investigated the effect of conceptual change texts accompanied with computer animations on 11th grade students' understanding and alternative conceptions related to chemical bonding. One experimental group and control group were choosen. While the control group taught traditional instruction, the experimental group received conceptual change text accompanied with computer animations instruction. Chemical bonding achievement test was applied as pre-test, post-test and delayed test to collect data. The result of the study showed that students in experimental group are better in remediating their alternative conceptions related to chemical bonding. Based on the study, it is concluded that conceptual change texts combined with computer animations can be effective instructional tools to improve students' conceptual understanding of chemical concepts.

Another study, Frailich, Kesner and Hofstein (2009) researched that effectiveness of a web-based learning environment in enhancing 10th grade high-school students' understanding of the concept of chemical bonding. One experimental group and control group were choosen. The teachers in the experimental group were asked to implement activities taken from a website, all dealing with the concept of chemical bonding. Computer-based visual models are utilized in all the activities in order to demonstrate bonding and the structure of matter, and are based on student-centered learning. The study incorporated both quantitative and qualitative research. The quantitative research consisted of achievement questionnaires administered to both the experimental and comparison groups. In contrast, the qualitative research included observations and interviews of students and teachers. The result of the study showed that the experimental group outperformed the comparison group significantly, in the achievement post-test, which examines students' understanding of the concept of chemical bonding. The web-based learning activities which integrated visualization tools with active and cooperative learning strategies provided students with opportunities to construct their knowledge regarding the concept of chemical bonding.

2.5 Constructivism

Constructivism is a psychological and philosophical perspective contending that individuals form or construct what they learn (Schunk, 1996). It is a theory of knowing not only a theory of learning. It describes what 'knowing' is and how one 'comes to know' (Bodner, 1986). The theory emphasizes the idea that students are active builders while they are constructing the knowledge. Constructivism focused on how people create and develop their ideas and constructivism in education are applied by designing curricula that accommodate students' understanding and which guide teachers (Driver et al., 1994). According to constructivism, meaningful learning is very crucial so that reason the connection between the new knowledge and the existing knowledge is very important. It is an epistemological concept that draws from a variety of fields, including psychology, science and philosophy (Walker and Lambert, 1995).

Constructivist's learning theory is based on the research of Piaget, Bruner, Vygotsky and Kuhn. Piaget has worked on his theory of intellectual development for nearly a life time. Piaget assumes that children impose their concepts on the world to make sense of it. These concepts are not inborn; rather children acquire them through their normal experiences. Information from the environment is not automatically received but rather is processed according to the child's prevailing mental structures (Schunk, 1996). Cognitive conflict strategies, derived from a Piagetian constructivist view of learning, are effective in teaching for conceptual change (Duit & Wilbers, 1999). According to Piaget, developmental process is constructed by equilibration, assimilation and accommodation. Piaget's theory assumes that cognitive development depends on biological maturation, experience with physical environment and social environment and equilibration. Equilibration is a biological drive to produce an optimal state of adaptation between cognitive structures and environments (Duncan, 1995). Assimilation refers that the constructing external reality to the prior cognitive structure. The third one is accommodation refers that the process of changing individual's existing structures to provide consistency with the external reality (Schunk, 1996). According to him, cognitive development can occur only when disequilibrium or cognitive conflict exists. When confronted with experiences that create disequilibrium which is a state of imbalance between assimilation and accommodation, children try to make sense out of this experience. This active process results in improved schemata. Piaget believed that these changes in structures are a major aspect of intellectual development. Piaget was the first reveal that children reason and think differently at different periods in their lives. He believed that all children progress through four different and very distinct stages of cognitive development. The theory is known as Piaget's Stage Theory deals with four stages of development, which are sensorimotor, preoperational, concrete operational and formal operational.

After the Piaget, Bruner highlighted that there are various ways that children represent knowledge. According to Bruner the development of human intellectual functioning was shaped by a series of technological advances in the use of mind. Bruner's constructivist theory is a general framework for instruction based upon the study of cognition. These technological advances depended on increasing language facility and exposure to systematic instruction. Also, he believed that what enables learners to develop the capacity for symbolic thinking when they have been thinking in iconic modes is related with interaction between genetic pre disposition and experience.

According to Vygotsky, social factors play a fundamental role in intellectual development. When external knowledge, existing in the culture, is internalized (or construct) by children, intellectual skills are provoked to develop. Thus, learning leads to development. Vygotsky and Piaget both believed that all children go through the same stages of development but at different rates. Vygotsky agreed that children's cognitive development took place in stages. He came into three general claims; first one is culture which is that higher mental functioning in the individual emerged out of social processes, second one is language which human social and psychological processes are fundamentally shaped by cultural tools, and third one is the developmental method Zone of Proximal Development (ZPD) which is the concept that the potential of the child is limited to a specific time span. For Vygotsky, acquisition of language from the social environment results in intellectual development.

Brooks and Brooks (1999) offered five guiding principles of constructivism that can be applied to the classroom.

1. The first principle is engage students in problems for emerging relevance to students. Teacher focus on students' interests and use their previous knowledge by this way, he or she motivate the students to learn. The relevant questions posed to the students will force them to ponder and question their thoughts and conceptions.

2. The second guiding principle is structuring learning around primary concepts. Teacher organize curriculum into activities which address broad main concepts. By use of broad concepts, students participated in irrespective of individual styles, temperaments, and dispositions.

3. The third principle is seeking and valuing students' perspectives. Teacher access to students' reasoning and thinking processes and challenge their students for to enable meaningful learning. In order to accomplish this, the teacher must be willing to listen to students, and to provide opportunities for this to occur.

4. The fourth principle is adapting curriculum to address students' suppositions. Teacher encourages students to investigate and challenge their assumptions and suppositions.

5. The last principle is assessing students learning in the context of teaching. This describes that traditional disconnect between the contexts/settings of learning versus that of assessment. Authentic assessment is best achieved through teaching; interactions between both teacher and student, and student and student; and observing students in meaningful tasks.

Also, Brooks and Brooks (1999) stated that constructivist classrooms implementing the guiding principles rely heavily on primary sources of data and manipulative materials. Teacher should view students as thinkers with emerging theories about the world and seek students' points of view in order to understand students' present conceptions and design group work for the students. Students come to the classroom with their prior ideas or knowledge, which they use to understand the new information. These prior ideas or knowledge affect the learning of new information of ideas (Osborne and Wittrock, 1985). From the constructivist perspective, students need to be active participants in the learning process in the constructing meaning and developing understanding (Jenkins, 2000).

Yager (1991) stated that the constructivist methots that the teachers used in the lesson are;

- encourage the student to ask questions and to use students' ideas and questions.
- to encourage the students to say their ideas.
- to permit the students leader
- to use students ideas and experiments in the lesson.
- to create discussion in the lesson
- to encourage the students to analaze and to formulate their ideas.

Research studies revealed that constructivist teaching strategies are useful not only improving achievement but also they help students construct their views about science and develop thinking ability. Carey et al. (1989) concluded that prior to the constructivist methodology that included scientific inquiry, most students viewed science as a way of understanding facts about the world. After the constructivist methodology, most of the students saw scientific inquiry as a process guided by questions and ideas. Constructivism approach has an important role in education. Its implications for how teachers teach and learn to teach are enormous. Based on a constructivism approach, instruction should be concerned with the experiences and contexts that make the students willing and able to learn (readiness); instruction must be structured so that it can be easily mastered by the student (organization); and instruction should be designed to facilitate extrapolation and or fill in the gaps (going beyond the information given) (Brune, 2002).

Teichert and Stacy (2002) investigated the effect of students' prior knowledge, integration of ideas with their existing structure and their explanations affected their conceptual understanding of the principles of thermodynamics and chemical bonding. Experimental group students participated in the intervention discussion sections whereas students in the control group were instructed traditionally. Using a curriculum that encouraged students' explanations of their conceptions made students gain a better understanding of bond energy and spontaneity.

2.5.1 Conceptual Change Approach and Conceptual Change Texts

Learning occurs by changing students' existing conceptions and adding new knowledge to what is already there. This is called conceptual change which is a model of learning (Posner, Strike, Hewson and Gertzog, 1982; Hewson, 1982). If there is a interaction between new and existing concepts in students' mind, learning occurs (Posner at al, 1982; Hewson, 1981). Posner at al. (1982) suggested the following criteria for changing students' misconceptions. These are:

1. Dissatisfaction must be occurring with students' existing knowledge.
2. Students must find the new knowledge intelligible.
3. Students must find the new knowledge plausible.
4. The new concept must be fruitful.

Many students can not do connection with the new knowledge and the existing knowledge. Consequently, they hold a lot of misconceptions about chemical bonds. In conceptual change texts, these four criteria are used in order to change the misconceptions. Conceptual change has been done in different ways like accommodation, reconstruction, replacing a concept (Taylor, 2001). In order to promote conceptual change two main grouping of strategies has been identified by Scott, Asoko and Driver (1991). The first strategy is cognitive conflict and the resolution of conflicting perspective. Second strategy focuses on students' existing ideas and extending them by using analogies and metaphors. Analogies express comparison of structures between two domains and identify similarities. In constructivism analogies are the effective tools in order to provide conceptual understanding. By using them meaningful understanding occurs in students' mind (Duit, 1991).

The interpretation of student responses as driven by alternative conceptions suggests that learning may involve changing a person's conceptions in addition to adding new knowledge to what is already there (Hewson, 1992). This view was developed into a model of learning as conceptual change by Posner, Strike, Hewson, and Gertzog (1982) and expanded by Hewson (1981, 1982). From this point of view, learning involves an interaction between new and existing conceptions with the outcome being dependent on the nature of the interaction. Duit, (1996) stated that conceptual changeas a context-appropriate change to the chemical concept and a broadening of the learned chemical concept. It is also described as a process of a change from the learner's prior conceptions to some intermediate conceptions then to scientific conceptions.

There are two major components of conceptual change model. First one is conditions that need to meet for a person to experience conceptual change. The conditions are determined as the status of a person's conception. If the conception meets the more conditions, its status will be higher. The other component of the conceptual change model is the person's conceptual ecology. It provides the context for a conceptual change to occur then meaningful learning is constructed learner's mind. According to conceptual change model, person's conceptual ecology has different kind of knowledge and it consist epistemological commitments. Person's conceptual ecology has an important role in determining the status of the person's conception. Because, it affect his or her judgments whether the conditions for conceptual change have been met (Hewson and Hewson, 1992).

Three kind of instructional strategies can be used in order to accomplish the conceptual change. First one is to use induction cognitive conflict by using students' misconceptions. Second one is to use of analogies in order to guide students' change. Third one is to promote collective discussion of students' ideas by using cooperative and shared learning. Research studies showed that discussion is one of the effective means of eliciting conceptual change (Nussbaum and Novick; 1982; Driver and Oldham 1986; Guzzetti et al., 1993).

According to constructivism, teaching sequence is very important for to promote the conceptual change in students' mind. Driver and Oldham (1986) proposed a teaching sequence for it. These are;

1. Orientation: a context for the instruction is presented and the relevance of the topic to the students established.

2. Elicitation: To give opportunities to the students in order to make their personnel conceptions explicit to their classmates and their teachers.
3. Restructuring, modification and extension: These are includes the activities which formed to allow students to exchange ideas with peers and construct and evaluate their ideas.
4. Application: To provide opportunity to the students in order to try out newly constructed concepts.

Chi, Slotta and de Leeuw (1994) developed a theory related to conceptual change. According to this theory, the reseachers stated that why some misconceptions cannot be replaced with scientific conceptions easily. They explained that scientific concepts belong to three different ontological categories as matter, processes and mental states. Concepts in the matter are more concrete than those in the processes or mental states. The ontological category of a concept determines the difficulty of learning. When student's scientific concept and ontological category of a student's concept are the same, the conceptual change occurs easily. On the contrary, when two conceptions are ontologically different, learning became difficult. If students have cognitive conflict, their mind confused in terms of ontological categories. If there is a mismatch between students' categorical representation and true ontological category of a concept, misconceptions occur in students' mind. By this way, conceptual change occurs when a concept changes its category.

Dykstra, Boyle and Monarch (1992) claimed that conceptual change is a progressive process of to change students' conceptions. The researchers identified taxonomy of conceptual change which is differentiation class extension and reconceptualization.

The teachers' role is very important in constructivism. Teachers must be facilitator who will provide the appropriate opportunities for the learners to undertake the construction. Nussbaum and Novick (1982) presented a design for learning activities which embodies a cognitive conflict strategy: students are expected to restructure their conceptions in order to accommodate results that present discrepancies when compared to predictions and explanations derived from their own ideas. This sequence occurs in the following order:

1. The teacher creates a situation which requires students to invoke their frameworks in order to interpret it.

2. The teacher encourages the students to describe verbally and pictorially their ideas.

3. The teacher assists them to state their ideas clearly and concisely.

4. Students debate the pros and cons of the different explanations that have been put forward. This will create cognitive conflict within many of those participating.

5. The teacher supports the search for the most highly generalisable solution and encourages signs of forthcoming accommodation in students.

Cosgrove and Osborne (1985) reviewed several instructional models and proposed a generative learning model of teaching which suggest:

1. The teacher needs to understand the scientist views and the students' and the teacher's views in relation to the related topic begin taught.
2. Opportunity must b given to the students in order to explore the context of the concept within a real situation and to clarify their own ideas as clearly as in the learning process.
3. Students discuss their ideas with each other and teacher gives the science view if it is necessary. The teacher needs to make the concept intelligible and plausible by demonstration, experimentation or analogy.
4. Teacher should provide opportunities to the students in order to apply their new ideas based on commonplace.

Several science education researchers (Hynd, McWhorter, Phares, and Suttles, 1994) stated that conceptual change approach provided a better acquisition of scientific conceptions in students' mind and they removed alternative conceptions. A conceptual change text is the one of the techniques that identifies and analyses student misconceptions and it refutes them from students' mind. Conceptual change text attempts to acknowledge the learners' existing conceptions and contrasts them with the more scientifically accepted conception, often through a historical progression. Conceptual change text illustrates inconsistencies between the misconceptions and scientific knowledge. (Kim and Van Dunsen, 1998). By this way, cognitive conflict occurs and application of new conception is constructed in students' mind (Hynd et.a1.1994).

Conceptual change text is designed to at least partially meet Posner, Strike, Hewson, & Gertzog's (1982) conditions for conceptual change. Guzzetti, Snyder, Glass, and Gamas (1993) stated that conceptual change text was more effective than regular text at producing conceptual change in students. Similiarly, Hynd and Alvermann (1986) suggested that conceptual change text is more successful and effective than demonstration, or group discussion in producing long-term conceptual learning of counterintuitive information. In order to engage students in conceptual change learning, teacher should lead to group discussions where students learn to discuss ideas in a variety of ways. In the classroom, students should express ideas and the reasons for them and discuss about consistency of ideas. In this way, they control their learning. Many studies have been done to explore effects of conceptual change text on students' conception and promoting meaningful learning in science course (Chambers and Andre, 1997; Tekkaya, 2003). Andre and Chambers (1997) investigated the relationship between gender, interest and experience in electricity, and use of conceptual change text on learning electric circuit concept. And they found that conceptual change text more effective than the traditional text in conceptual understanding of electric circuit concept. Also they stated that conceptual change texts can be used effectively in both small and large classrooms to facilitate conceptual change.

Papuçcu and Geban (2006) explored the effects of conceptual change texts oriented instruction on ninth grade students' understanding of chemical bonding concepts. They used the conceptual change texts in order to activate students' prior knowledge and misconceptions and to help them to understand the chemical bonding concepts through the use of instructions, analogies and examples. Researchers used analogies in the conceptual change texts in order to eliminate students' misconceptions more effectively. The results supported that conceptual change texts oriented instruction have positive effect on students' understanding of scientific conceptions related to chemical bonding and elimination of misconceptions.

Uzuntiryaki (1998) investigated the effect of conceptual change texts accompanied with concept mapping instruction through the instructor lecture on 8 grade students' understanding of solution chemistry. Result of the study showed that the conceptual change text accompanied with concept mapping instruction caused a significantly better acquisition of scientific conceptions than the traditionally designed chemistry instruction.

Çakır, Uzuntiryaki and Geban (2002) investigated the effects of concept mapping and conceptual change texts instructions over the traditional instruction on tenth grade students' understanding of acid and base concepts. 110 students participated to the study. Two of the classes were first experimental groups and they were instructed with conceptual change text instruction. Other Two of the classes were second experimental groups and they were instructed concept mapping instruction. The last two of the classes were control group and they were instructed with traditional method. Pre-test and Post-test related to acid and base concepts were conducted to the all students in the study. The result supported that conceptual change and concept mapping instruction provide significantly better understanding of acid and base concepts that the traditional instruction.

2.6 Analogies

An analogy expresses an abstract idea about the topic. Analogy refers to comparisons of structures between two domains. An analogy gives the similarities between the structures of two domains. It serves a creative function when it stimulates the solution of existing problems, the identification of new problem and generation of hypothesis (Glynn et al, 1989). Chemistry to be understood fully needs to be experienced either visually or cognitively. Teaching chemistry concepts through analogies can benefit students at the learning process. Analogies help teacher to attract students' attention to the subject, makes students more interested and focused on what may happen. Thus, students become more enthusiastic about spending time studying the topic comprehensively. Teachers use analogies to aid understanding of complex abstract, scientific concepts. As might be expected, the concepts deemed most likely to benefit from the use of analogy are those which students find conceptually difficult such as atomic structure and chemical bonding (Coll & Treagust, 2002).

Analogies are powerful tools of explanation. Many researchers stated that using analogies as explanatory devices can be a useful way to teach science (Glynn, 1997; Beall, 1999; Heywood, 2002; Rule, and Furletti, 2004; Yanowitz, 2001), and facilitate students' meaningful learning and text learning (Glynn and Takahashi, 1998). Analogies are used constantly to help make meaning clear. By using analogies students can compare the concrete examples and can link the anchoring concepts. Analogies connect one specific example with another. Analogies provide the students opportunities to think with their prior concepts and construct their new knowledge (Beall, 1999). When the students construct the new knowledge, they give meaning to the new information and they are learning. The comparative nature of analogies promotes meaningful learning. Thus, the relation between new understandings and the real world motivates students to learn more (Heywood, 2002).

Analogies are significant in constructivist approach. Analogies help student to learn the abstract concepts. Students may link the new knowledge and their existing knowledge in the analogy and they construct their own knowledge by using them. Duit, (1991) asserted that: "It is the analogy relation that makes a model a model". Such an assertion was made from the recognition that models, as analogies, "have to do with the structural mapping of different domains". According to this view, there are three components of analogy. Duit represented the process of creation of a model through the figure:

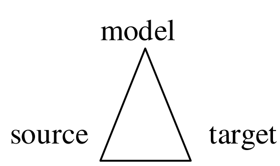

Figure 2.1 Creation of Model

“Target” is the aspect of reality that is being modelled. It may be an event, object, an a process or an idea. “Source” is some more familiar entity that is used to represent the target through the production of an analogy. “Model” is the result of this representation.

Duit (1991) and Glynn (1991) stated that all analogies have unshared characteristics and they all break down somewhere. Therefore, Glynn developed his six-step Teaching-With-Analogies (TWA) model. In spite of use of Glynn’s model is apparent, teachers regularly forgot to carry out one or more steps. Treagust et al. (1998) researched many school, teachers and lesson than proposed the Focus—Action—Reflection (FAR) guide. This guide has three stages for the systematic presentation of analogies and resembles the planning phases of expert teaching and the action research model. The FAR guide is illustrated in Figure 1. When teachers used analogies by the help of FAR guide framework, students’ scientific understanding is enhanced and the variety and frequency of alternative conceptions are diminished (Harrison & Treagust, 2000).

Pre-Lesson FOCUS **CONCEPT** Is the concept difficult, unfamiliar or abstract? **STUDENTS** What ideas do the students already have about the concept? **EXPERIENCE:** What familiar experiences do students have that I can use?
In-Lesson ACTION Check student **familiarity** with the analog. **LIKES (mapping)** Discuss ways in which the analog is **like** the target Are the ideas surface features or deep relations? **UNLIKES (mapping)**Discuss ways in which the analog is **unlike** the target.
Post-Lesson REFLECTION **CONCLUSIONS** Was the analogy clear and useful, or confusing. **IMPROVEMENTS** What changes are needed for the following lesson? What changes are needed next times I use this analogy?

Figure 2.2 The FAR Guide for Teaching with Analogies and Models (Treagust et al., 1998)

If the teachers use analogies successfully, students modify their existing cognitive structure Cosgrove (1995) stated that analogy is excellent thinking tool in school science provided the teacher understands the concepts being taught and can guide the students' learning inquiry process. He claimed that the best analogies are student generated and in the absence of student analogies. But, teacher analogies that are multiple and presented in a format like the FAR guide can enhance learning.

Analogies enhance understanding by making connections between scientific conceptions and students' ideas. Analogies provoke students' interest and their motivation. Connection between the analog and the target concept must be established carefully. Uncritical use of analogies may generate misconceptions. (Duit, 1991). So, teacher must use analogies with grater care. Also, teacher must choose the analog familiar to the learners. Cosgrove (1995) demonstrated that analogy is an excellent thinking tool in school science provided the teacher understands the concept being taught and can guide his or her students in the inquiry process. As Curtis and Reigeluth (1984) researched 26 science textbooks and they classified the analogies in three catagories. These are simple analogy, enriched analogy and extended analogy. The most common type that used in textbooks is simple analogy. In this analogy the writer says that something like 'activation enery is like a 'hill'. The second one is enriched analogy. It tells the students under what conditions that analogy holds. For example 'activation energy is like a hill because you have to add energy to the reacting substances to start the reaction.' Simple analogy is descriptive but enriched analogy is more explanatory. The third one is extended analogy. It contains mix of simple and enriched analogy. The 'eye is like a camera' analogy is extended analogy.

Analogies are useful tools and there are positive affects in learning. Many research reported the positive affect of analogy usage in science (Gabel & Samuel, 1986; Duit, 1991; Harrison and Tragust, 1993; Venville and Treagust, 1996; Yanowitz, 2001).

In chemistry, chemical bonding is a very difficult subject for many students and there are a number of comments in the literature with authors suggesting that teachers should use analogies when teaching bonding theories. Licata (1988) used an analogy for covalent bonding related to eating one's lunch. Sharing one's lunch is a non-polar covalent bond, unequal sharing of lunch is a polar covalent bond, and stealing someone's lunch is a co-ordinate covalent bond.

Another study, Gabel and Samuel (1986) conducted a study to determine the effects of analogies when solving molarity problems. Result of the study showed that students success enhanced by the usage of analogies. So, connection between the analog and the target conception must be seen by the students in order to make analogical reasoning successfully. If the students familiar with the analog domain, analogical reasoning can be successful.

Brown and Clement (1989) stated that the use of analogies help students to develop their ideas and to serve as a reference point to check on plausibility of their previous explanations. Analogy provides a tool for thinking and explanation and help students to meaningful relations between what they already known and what they are setting out to learn. Also, Pogliani and Berberan-Santos (1996) suggest that there are important role educational value of the many analogies between the human behavior and chemical behavior. In their study, they used an analogy (inflation and devaluation of motor vehicles) which help to understand chemical kinetics.

On the other study Brown (1992) explored the effects of examples and analogies on remediating misconceptions in physics. The subjects of the study were 21 high school volunteer chemistry students. Each of them was interviewed by the researcher and was presented either text excerpts or bridging explanations that were randomly assigned to different groups. Pre-test and post-test used during the study. Analysis showed significant results in favor of bridging analogies.

Yanowitz (2001) tried to determine the effects of analogies in the text. He used control and experimental group in the study. Analogical text was used in the experimental group and expository teaching was used in the control group. As a result of the study, students who instructed with analogical texts showed better inferential reasoning then the students in instructed expository texts. Usage of anthropomorphism and animism in the textbooks and usage those by the teachers may lead to misunderstanding in students' mind. Nakiboğlu and Poyraz (2006) explored the usage of anthropomorphism and animism in university chemistry students' explanations related to atom and chemical bonding. They used a misconception diagnostic test concerning atom and chemical bonding. 324 university chemistry students participated to the study. At the end of the study it was seen that students used the terms such as 'need, grab, want, try' unique to human beings.

Orgill and Bodner (2003) studied on biochemistry students' perceptions of analogies and their use in biochemistry classes. They interviewed 43 students from two introductory biochemistry classes and one upper level chemistry class. They asked the students advantages and disadvantages of analogies, how students use analogies, if they like analogies, how analogies should be used to be effective in instruction and what the students understood about these analogies. They analyzed the students' answers and they stated that most of the students like analogies and they remember the instruction when the analogy used. Researchers said that students use these analogies to understand, visualize and recall information from class.

Harrison and Treagust (2000) stated that science teachers must be carefull some criteria while they are using analogies:

- the suitability of the analog to the target for the student audience and the extent of teacher-directed or student-generated mapping needed to understand the target concept;
- an understanding that an analogy does not provide learners with all facets of the target concept and that multiple analogies can better achieve this goal;
- an appreciation that not all learners are comfortable with multiple analogies because the epistemological orientation of some is to expect a single explanation for a phenomenon.

Although, analogies are commonplace in communication, sometimes they are not as effective in the classroom as might be expected. (Duit, 1991) If they are used uncritical place, they may cause misconceptions. (Champagne, Gunstone & Klopfer, 1985) and this is especially so when unshared attributes are treated as valid (Osborne&Cosgrove, 1983; Curtis & Reigeluth,1984) or when where the learners are unfamiliar with the analogy(Gentner & Gentner, 1983; Nagel,1961) So, analogy must be used with greater care and the analog must be true description of target concept. Models and analogies have an important role in all science disciplines (Gilbert, 1998). But, they seem to be one of the factors that cause difficulty in unerstanding of chemistry students because they not only have to understand so many symbols, terminology and theories but also have to transform instructional language or materials taught by their teachers into meaningful representations (Chiu, 2005). The meaning of some words in chemistry is different from their everyday meanings so that reason the language used in chemistry can make learning difficult (Herron, 1996).

Based on implications in the literature, the methodology of teaching has strong influence in understanding of science. According to related literature, conceptual change texts and analogies are seem to be satisfactory instruction tools in order to enhance the students' understanding of chemical bond concepts. So that reason I prefer to use them in this study.

2.7 Relation of Attitude and Achievement

Students' attitudes toward science, mathematics or another lesson affect their achievement on this lesson. There are many studies which explore the relation of students' attitudes toward related lesson and achievement. Results of the studies provided evidence that there is a relationship among instruction, achievement and attitude (Duit, 1991; Rennie and Punch, 1991; Francis and Greer, 1999; George, 2000; Çetin, 2003).

Talton at al. (1987) examined the relationship of classroom environment to attitudes toward science and achievement in science among tenth grade biology students. An attitude instrument was administered at three times during the school year to measure student attitudes toward science and the classroom environment. The classroom environment measures examined six areas: emotional climate of the science classroom, science curriculum, physical environment of the science classroom, science teacher, other students in the science classroom, and friends attitudes toward science. Student achievement in science was measured by teacher reported semester grades. The study showed that: (1) student attitudes toward the classroom environment predicted between 56 to 61% of the variance in attitudes toward science, (2) student attitudes toward the classroom environment predicted between 5 to 14% of the variance in achievement in science, (3) student attitudes toward science and attitudes toward the classroom environment predicted between 8 and 18% of the variance in achievement in science.

Weinburgh, (1995) researched gender differences in student attitudes toward science, and correlations between attitudes toward science and achievement in science. Results of the study showed that gender differences in attitude as a function of science type indicate that boys show a more positive attitude toward science than girls in biology, physics and chemistry. The correlation between attitude and achievement for boys and girls as a function of science type indicated that for biology and physics the correlation is positive for both, but stronger for girls than for boys. Gender differences and correlations between attitude and achievement by gender as a function of publication date showed no pattern. The researcher stated that general level students reflect a greater positive attitude for boys but, the high-performance students indicate a greater positive attitude for girls. The correlation between attitude and achievement as a function of selectivity indicated that in all cases a positive attitude results in higher achievement. This is approximately true for low-performance girls.

George (2000) investigated the change in the students' attitudes toward science over the middle and high school years using data from the Longitudinal Study of American Youth. The results of the study indicated that students' attitudes toward science in middle and high school years generally decreased. The science teacher role is important. If the teacher encourages the students, their attitudes were also affected in a positive way and teacher is a significant predictors. But the effects of parents were found to be quite small and statistically non-significant, with the exception of the seventh grade in the study.

Uzuntiryaki (2003) studied on the effect of constructivist teaching approach on students understanding of chemical bonding concepts and attitudes toward chemistry as a school subject. The results of the study showed that the instruction based on constructivist approach had a positive effect on students' understanding of chemical bonding concepts and produced significantly higher positive attitudes toward chemistry as a school subject than the traditionally designed chemistry instruction.

Doymuş, Şimşek and Bayrakçeken (2004) explored effets of cooparative learning on students' attitudes toward science and achievement. Also they explored students' views on cooparative learning. 59 students participated to the study. Control and experimental groups were constituted. Cooparative learning model was used in experimental group and traditional methods was used in control group. Science achievment test and attitudes toward science test were used. Also, grupla çalışma görüş test was used. Result of the study showed that there is a significant difference in students' achievment on science and attitudes towards science in experimental and control group. Students' achievment and attitudes towards science in experimental group are better than the students in control group.

Akçay, Tüysüz and Feyzioğlu (2003) investigated effects of computer aided learning method in primary science classroom students' achievment on mole concept and Avagadro's number concept and students' attitudes toward science. 103 eight grade students participated to the study. Students were assigned the experimental and control group. Conventional learning approach was used in the control group and teacher centered computer-aided education was used in experimental group. Five instruments were used were used in the study as pretest and post test. Science Achievment Test, Computer Attitude Scale, Science Attitude Scale, Logical

Thinking Ability Test was used. Experimental and control groups were compared. Result of the study showed that students' attitudes towards computer, science and science teacher in experimental group showed a significant and positive change than the students in control group. Achievment toward science was not different in two groups. Also they found that there was no significant difference in gender.

Üce, Sarıçayır and Demirkaynak (2003) explored the effect of classical and experimental teaching methods on successful learning of acid-base concept in chemistry. Chemistry Attitude Test was applied to the students to evaluate if the experimental method had influenced their attitudes towards chemistry. Also, Logical Thinking Ability Test and Scientific Achievement Test were applied to collect the data. Two (grade 10) classes from a high school were selected. Experimental and control group were designed. Students in control group were instructed by classical method and their success in learning was compared with that of the students in experimental group in which experimental method was applied. In this group, part of instruction was made in the laboratory to enable the students to perform experiments within a group. The researchers found that the instruction by the experimental method improved the students' success in learning the acids and bases subject significantly compared to the overall success of the students taught by the classical method. But, there is no significant difference between groups in attitudes towards chemistry.

The extensive research on students' conceptions shows that students have misconceptions that influence their understanding of the science concepts during and even after instruction. Chemistry is one of the difficult science subjects. Especially, students have difficulties in understanding concepts which can not be visualized. Chemical bond concepts because of their abstract nature are difficult to be learned. Incorrect interpretations of daily experiences about chemical bond also add some incorrect conceptions to the students' minds. Conceptual change based teaching methods seem to be effective in remedying students' misconceptions. For this reason, in this study, we examined the effectiveness of the conceptual change oriented instruction accompanied by analogy on students' understanding of chemical bond concepts and their attitudes toward chemistry as a schools subject when students' science process skills were controlled. In present study, we used analogies to make connection between analogies and conceptual change; to make concept acquisition; to increase students' motivation; to increase intelligibility and plausibility of new concepts.

2.8. Interview Method

Interview method is used to gain access to student ideas, thoughts, misconceptions, etc, which cannot be easily identified through observation alone (Roberts, 1982). Interview method is usefull in order to determine students' ideas in science. This important method for conducting constructivist research is based on the work of Piaget (1950). Interview method involves collecting verbal data from students in non-classroom situations and has been found successful and helpful to investigate students' understanding (Yarroch, 1985; Nakhleh, 1990; Shapiro, 1994). Interviews have been successfully used in many science and education research investigations; the particulate nature of matter (Griffiths & Preston, 1992; Ebenezer & Erickson, 1996), chemical events (Boo & Watson, 2001), chemical bonding (Coll & Treagust, 2001).

The examples studies show interviews play a very important role in science education research because detailed information on students' understanding of chemical concepts can be obtained. A clinical interview format contains a variety of techniques such as "interview about instances", "interview about events", "prediction-observation-explanation", student drawings and word association tasks (White, & Gunstone, 1992). Frequently, such studies use interview techniques that are structured by an interview guide. An interview guide is a list of interview questions planned in advance to ensure the same topics are covered with each interviewee (Patton, 1990). This method has been used in many studies on science education. In the present study, the interview guide method was used for interview.

There are four types of interviews. These are structured, semistructured, informal and retrospective. Structured and semistructured interviews are verbal questionnaires. They are most useful for obtaining information to test a specific hypothesis that the researcher has in mind. They are conducted at the end of the study. In the present study structured interview was conducted. Also, there are some interview techniques. These are interview about instances, interview about events, Prediction-Observation-Explanation and drawings. The present study used interview about instance and drawings tecniques. The "interview about instances" technique is used to explore students' understanding of ideas associated with a particular label (Gilbert, Watts & Osborne, 1985) and some conceptions that were found before and after formal teaching of science. Gilbert (1981) described the technique, research subjects were asked to classify examples represented as line drawings on card, or word such as electric current, work, force, and to explain the reasons for each classification. The present study used this approach in the interview, what students' ideas about ionic and covalent bond were probed. The "drawings techniques" are used to assist researchers for collecting data because drawings are open-ended, facilitate a relaxed atmosphere and give a natural tool for respondents to express their ideas and understandings, which may not be easily found from other procedures. Nakhleh, (1994) claimed that the information about students' views on the particulate nature of matter, the role and nature of the solute and solvent revealed from their drawings was more than could be obtained from verbal or written data. In the interview technique coupled with drawings by the respondents, students are asked to draw what they see or what they will see in a given event or imagine what they can see for some non-visible objects such as atoms, ions, water molecules or bonding etc. This technique has been used in some previously studies (Yarroch, 1985; Nakhleh, 1990; Harrison & Treagust, 2000; Coll &Treagust, 2003). In the present study, students were asked to draw an example for ionic compound and covalent compound.

CHAPTER III

PROBLEMS AND HYPOTHESES

3.1 The Main Problem and Sub-problems

3.1.1 The Main Problem

The main problem of this study is:

What are the effects of conceptual change oriented instruction accompanied by analogy and gender on eight grade students' understanding of concepts related to chemical bond, and attitudes toward science as a school subject?

3.1.2 The Sub-problems

In this study the following sub-problems have been stated:

1. Is there a significant mean difference between the effects of conceptual change oriented instruction and traditionally designed science instruction on students' understanding of concepts related to chemical bond when the effect of science process skills test is controlled as a covariate?

2. Is there a significant difference between females and males in their understanding of concepts related to chemical bond concepts when the effect of science process skills test is controlled as a covariate?

3. Is there a significant effect of interaction between treatment and gender with respect to students' understanding of concepts related to chemical bond concepts when the effect of science process skills test is controlled as a covariate?

4. What is the contribution of students' science process skills to their understanding of concepts related to chemical bond?

5. Is there a significant mean difference between students taught trough conceptual change oriented instruction and traditionally designed science instruction with respect to their attitudes toward science as school subject?

6. Is there a significant mean difference between males and females with respect to their attitudes toward science as a school subject?

3.2 Null Hypotheses

$H_0$1: There is no significant difference between the post-test mean scores of the students taught with conceptual change oriented instruction and students taught with traditionally designed science instruction in terms of concepts related to chemical bond when the effect of science process skills is controlled as a covariate.

$H_0$2: There is no significant difference between the post-test mean scores of females and males with respect to understanding of concepts related to chemical bond when the effect of science process skills is controlled as a covariate.

$H_0$3: There is no significant effect of interaction between treatment and gender on students' understanding of concepts related to chemical bond when the effect of science process skills is controlled as a covariate.

$H_0$4: There is no significant contribution of students' science process skills to understanding of concepts related to chemical bond.

$H_0$5: There is no significant mean difference between students taught with conceptual change oriented instruction and traditionally designed science instruction with respect to their attitudes toward science as a school subject.

$H_0$6: There is no significant difference between post-attitude mean scores of females and males.

CHAPTER IV

DESIGN OF THE STUDY

4.1 The Experimental Design

In this study the Non Equivalent Control group design as a type of Quasi-Experimental design was used (Gay, 1987). The random assignment of already formed classes to experimental and control groups was employed to examine treatment effect. Intact classes were used because it would have been too disruptive to the curriculum and too time consuming to have students out of their classes for treatment. In addition, due to administrative rules the classes were chosen randomly not students. The research design of the study is presented in Table 4.1.

Table 4.1 Research Design of the Study

Group	Before Treatment	Treatment	After Treatment
EG	**pre-CBCT** **ASTS, SPST**	**CCIA**	**post-CBCT** **ASTS**
CG	**pre-CBCT** **ASTS, SPST**	**TDSI**	**post-CBCT** **ASTS**

In table 4.1, EG represents the experimental group instructed by the conceptual change oriented instruction accompanied analogies (CCIA). CG represents the control group instructed by the traditional instruction (TDSI). While the control group was instructed by TDSI that involved lecturing, the experimental group was instructed by conceptual change oriented instruction accompanied by analogies.

CBCT is the Chemical Bond Concept Test, ASTS is the Attitude Scale toward Science, SPST is the Science Process Skills Test. To investigate the effect of the treatment on students' achievement and understanding levels of chemical bonds, attitudes towards science, the CBCT and ASTS were administered to all subjects as pre- and post-tests. Additionally, the SPST was given to all subjects only before the treatment.

Two teaching methods were randomly assigned to the classes. The equivalence of the groups with regard to initial level of understanding of chemical bond concepts and their attitude toward science was ascertained from the pre-tests (ASTS, CBCT). Experimental and control groups were trained by the same teacher. She has 10 years previous teaching experience of elementary school of science and technology teacher. Each group instruction was four 40-minute sessions per week and the topic was addressed over a 3-week period. Before the treatment, the teacher was informed what the conceptual change oriented instruction accompanied by analogies was and how it could be used. The control group received traditional instruction based on lecturing and discussion in class. Although the experimental group was taught by conceptual change oriented instruction accompanied by analogies, both of the groups got the lessons in their classrooms. Experimental and control groups were assigned the same homework questions and used the same textbook.

Prior to the treatment, pilot test of Chemical Bond Concept Test was conducted. The sample of CBCT was chosen according to stratified sampling. The pilot CBCT was administered to 65 eight grade students.

4.2 Population and Sample

The target population of the sample is all eight grade elementary school students enrolled in a science course in Turkey. The accessible population includes all eight grade school students in science classes at elementary school in Ankara, Turkey. The results of the study would be generalized to the accessible population and the target population.

The subjects of this study included 50 eight grade students from two randomly selected science classes taught by the same teacher. The study was carried out during the Spring Semester of 2010-2011. These schools use a common curriculum established by Turkish Ministry of National Education.

The classes were chosen among three science classes at a public elementary school by a random sampling. Two teaching methods were randomly assigned to the classes. The experimental group consisted of 25 students while the group instructed by the traditional instruction consisted of 25 students. There were 27 female and 23 male students in the experimental group. The average of the subjects' ages is approximately 14 or 15.

4.3 Variables

4.3.1 Independent variables

The independent variables of this study were conceptual change oriented instruction accompanied by analogies and traditional instruction, gender and science process skills test scores (SPST). SPST was considered as continuous variable and was measured on interval scale. Instruction type or treatment and gender were considered as categorical variables and were measured on nominal scale. Treatment was coded as 1 for the experimental group and 2 for the control group. Students' gender was coded as 1 for female and 2 for male students.

4.3.2 Dependent variables

The dependent variables in this study were students' conceptual understanding of chemical bonds concepts measured by pre-CBCT and post- CBCT. Students' attitude towars science scores measured ASTS.

4.4 Instruments

There were four tools used to collect data used in addressing the research questions of the present study. These were the Chemical Bond Concept Pre-Test (pre-CBCT), the Chemical Bond Concept Post-Test (post-CBCT), Attitude Scale Toward Science (ASTS) and Science Process Skills Test (SPST).

The conceptual change oriented instruction, which was introduced to the students in the experimental group, was accompanied by analogies that were prepared as result of a careful examination of the literature, and variety of science and technology textbooks.

4.4.1 The Chemical Bond Concept Test

The test was developed by the researcher. Prior to the selection and development of the test items, the instructional objectives of the Chemical Bond unit were stated (See Appendix A). The Chemical Bond Concept Pre-Test (pre-CBCT) was prepared according to seven grade students' chemical bond knowledge. Eight grade science and technology textbooks and questions used previously in the studies related to students' misconceptions regarding chemical bond were used in constructing the Chemical Bond Concept Post Test (post-CBCT). The tests were examined by two experts in science education and by the science teacher for the appropriateness of the questions to the instructional objectives.

Prior to the treatment, pilot test of Chemical Bond Concept Test was conducted. The sample of CBCT was chosen according to stratified sampling. The pilot CBCT was administered to 65 eight grade students from one elementary school in the second Semester of 2009- 2010. Students' CBCT scores ranged from 0 to 20. The alpha reliability of the test was found to be 0.72.

The pre-test should consist of 25 items (See appendix C) and it should take approxiametly 25 minutes to complete by an average students. The pre-test questions prepared according to students seven grade science and technology knowledge.

Also, the pos-test should consist of 25 items (See appendix B) and it should take approxiametly 30 minutes to complete by an average students. Each question in the pre-stest and post-test will have one correct answer and other choices will be distracters. Distracters of items will involve the misconceptions. The tests were administered to subjects under standard conditions. In order to provide content validity, the test was examined by a group of expert in science education for appropriateness of the items. The data was collected directly from the subjects and the instruments that were used to collect data are multiple choice achievement test. In this study two written tests were used. These tests were chemical bonds conceptions test and attitude scale toward science as a school subject. During the development stage of the test, the alternative conceptions of the students about chemical bonds were determined from the related literature in this topic. Therefore, it can be expected to be determined misconceptions about chemical bonds concepts for the students who give the wrong answer.

Firstly, It was developed the behavioral objectives on the content of chemical bonds by using Science and technology education textbook printed by Turkish Ministry of National Education (Tunç at al. 2008). Then it was constructed the table of specification. By using this table, it was searched for the test items matching exactly with the objectives and the content of the study. The items should not any advantage to one of the gender, by using any terms known only by boys or girls. It was choosen the convenient test items from the other science and technology textbooks.

The classification of the students' misconceptions was constructed as a result of the examination of the literature related to the chemical bond concepts (see Table 4.2)

Table 4.2 Classifications of Students' Misconceptions About The Aspect of Chemical Bond Concept

Misconceptions	Item
●All atoms make chemical bond.	8A,8D
●When the chemical bond occurs, number of proton in atom changes	6C,6D
●When the chemical bond occurs, number of neutron in atom changes.	6A,6D
●Proton transfer occurs in ionic bond.	8C,8D
●Metals can make covalent bond.	9D
●Metals don't make compounds with noble gas but they can make compound with others.	10A,10C
●Metal and nonmetal don't make ionic bond.	10C,10B
●Atoms who have 2 or 3 electrons in the last shell make ionic bonds	11D
● If the atoms in molecule are different, molecule has polar bond	12A,12B12D
●Covalent bonds occur by the transfer of electrons.	13A,13C
●Electron sharing occurs in ionic bond	13A,13B
●Noble gas and nonmetal make covalent bond.	14C,5C,5D
●Metal and noble gas make covalent bond.	14D
●Metal and nonmetal make covalent bond.	14A,16C
●H,O,C,S can make ionic bond with themselves, in other words two nonmetal can make ionic bonds.	7B,7C,7D
●NaCl and CaCl have covalent bond.	2A
●HCl and H_2SO_4 have not covalent bond.	2C,2D
●Atom that has 3 electrons in last shell can make covalent bond with atom that has 6 electrons in last shell.	3B,3D

Table 4.3 (Continued)

Misconceptions	Item
●Atom that has 3 electrons in last shell can make covalent bond with atom that has 7 electrons in last shell.	3C,3D
●Atom that has 2 electrons in last shell don't make ionic bond with atom that has 6 electrons in last shell.	4A,4D
●Atom that has 1 electrons in last shell don't make ionic bond with atom that has 6 electrons in last shell.	4C,4D
●Elements in the group of 1A and 2A in periodic table make ionic bond with themselves.	5A
●Molecular compounds have ionic bond.	15B,15C,15D
●Element in the group of 8A make covalent bond with nonmetal.	16C, 16D
●Element in the group of 1A and 2A make ionic bond.	16A, 16C, 16D
●Anion and cation do not make chemical bond.	17B,17C,17D
●Particles of ionic compounds are molecules.	18B
●Particles of covalent compouns are molecules	18A, 18D
●Molecular compound models have ionic bond.	19B,19C,19D
●Atom that has 5 electrons in last shell can make covalent bond with atom that has 1 electrons or 3 electrons in last shell.	20C,20B
●Atom that has 3 electrons in last shell can make covalent bond with atom that has 8 electrons in last shell.	20D
●Identical ions(anion-anion or cation-cation) are closer than anion- cation.	21D
● (+) ion and (-) ion are far away between.	21A,21B

Table 4.4 (Continued)

Misconceptions	Item
●NaCl contains molecule and it has covalent bond.	22B,22C
●CO_2 does not contains molecules and it has ionic bond.	22A,22C
●Iodine atoms have ionic bond.	23C
●Iodine atoms do not share their electrons.	23D
●Compounds have not chemical bonds but, mixtures have chemical bonds	25B,25C,25D
●Particles of ionic compounds are molecules.	24C
●Particles of ionic compounds are only cations.	24B
●Particles of ionic compounds are atoms.	24 A

This post-CBCT was developed by the researcher and for the content validity the test was examined by a group of expert in science education for appropriateness of the items. There were 25 multiple choice items in the test. Each question had one correct answer and the other choices are distracters. Questions were asked the students make a conceptual prediction about a situation. Distracters of items involve the misconceptions and its possibility to choose the distracters in the test. Misconceptions in the test were given in Appendix B.

The test items in CBCT included;

- Distinction of covalent and ionic bonding.
- Properties of covalent bond.
- Properties of ionic bond.
- Metals and nometals role in ionic and covalent bond.
- The meaning of number of proton, electron and neutron in chemical bond.
- Affects of elements location in periodic table to chemical bond.

- To determine the kind of chemical bond according to atomic number of elements.
- Distinction of ionic and covalent bond by examining molecular or ionic structure in compounds.

The items 1,5,14 in the test were related to properties of ionic and covalent bond. Each question was asked to students in different type.

In the first question there were given information about the properties of chemical bond and it was questioned which information is true.

In the fifth question, it was given an example for ionic bond and there was given three interpretations about this example and it was asked which interpretation is true.

The item 2 and 6 in the test were related to metal and nonmetal's role in ionic and covalent bond.

The item 3 and 4 in the test were related to determination the kind of chemical bond according to atomic number of elements.

-determination of bond type according to atomic number of elements was tested by item 3 in the test.

-determination of covalent bond between elements according to atomic number of element was tested by item 4 in the test.

The item 7 in the test was related to distinction of ionic and covalent bond according to shapes of molecules.

The item 8,10,11 in the test were related to determine the kind of chemical bond according to electron numbers in the last shell of the atom.

-Determination of charge of atom according to electron numbers in the last shell of the atom and identify the bond type was tested by item 10, 11 in the test.

-Discriminate who did not make chemical bond according to electron numbers in the last shell of the atom was tested by item 8 in the test.

The item 2 in the test was related to determine bond type by making distinction of metals and nonmetals.

The item 6 in the test was related to determine the role of metals and nonmetals in ionic and covalent bond by using analogy in the question.

The items 12, 15 in the test were related to determine the kind of chemical bond in compounds.

- Determination of covalent bond in compounds was tested by item 12 in the test.
- Determination of ionic bond in compounds was tested by item 15 in the test.

The item 13 in the test was related to determine whether or not there is change on the numbers of neutron, proton and electron while making a chemical bond.

The item 16 in the test was related to determine covalent bond type according to given atom model in the pictures.

The item 17 in the test was related to properties of chemical bond. Students identify bond type of the atoms accordind to their atomic number and number of electrons.

The item 18 is related to particles of ionic compounds and molecular compounds.

The item 19 is related to discriminate chemical bond type according to molecular compound models.

The item 20 is related to determine chemical bond type according to electrons in last shell of the atom.

The item 21 is related to properties of negative and positive ions.

The item 22 is related to identify bond type of NaCl and CO_2 compounds.

The item 23 is related to determine chemical bond type according to molecular compound model.

The item 24 is related to properties of ionic compounds.

The item 25 is related to discriminate whether or not given compounds and mixture have chemical bond.

The achievement test that was used in the present study was developed by the researcher according to following procedure.

1) Instructional objectives of the unit 'chemical bonds' in the curriculum were followed and they were stated in Appeddix A.
2) The literature related to students' misconceptions on chemical bonds was examined.
3) Students' misconceptions on chemical bonds were classified and they were stated in table 4.1.
4) Every item in the test was constructed in terms of instructional objectives and misconceptions related to chemical bonds concepts.

4.4.2 Attitude Scale toward Science (ASTS)

This scale was developed by Geban and Ertepınar (Geban etal., 1994). It was used to measure students' attitudes toward science as a school subject. This scale consisted of 15 items in 5-point likert type scale: fully agree, agree undecided, disagree, and fully disagree in Turkish. This sclae is 5 point and it covered both positive and negative statements. The reliability was found to be 0.82. This test was given to students in both groups before and after the treatment (See Appendix D). Total possible ASTS scores range is from 15 to 75. While lower scores show negative attitudes toward science, higher scores show positive attitudes toward science.

4.4.3 Science Process Skills Test

This test was originally developed by Okey, Wise and Burns (1982). It was translated and adopted into Turkish by Geban, Askar, and Özkan (1992). This test contained 36 four-alternative multiple-choice questions. The reliability of the test was found to be 0.85. This test measured intellectual abilities of students related to identifying variables, identifying and stating hypotheses, operationally defining, designing investigations, and graphing and interpreting data (See Appendix E). Total possible score of the SPST was 36. The test was given to all students in the study.

4.4.4 The Interview Scales

When the treatment finished and the post-tests were administered to all of the students the researcher interviewed with some of the students from the experimental and control groups.

The interviews with the students were conducted in a structured form. Interview questions were prepared on the basis of the common misconceptions found in the literature related to the chemical bond concepts. The questions focused on 1) defining chemical bond 2) defining ionic bond and explaining ionic bond's properties, 3) defining covalent bond and explaining covalent bond's properties 4) discriminate who make bond with each other for metal, nonmetal and noble gas. 5) particles of ionic compounds 6) particles of covalent compounds 7) drawing an example for ionic and covalent compounds 8) last question was asked to take students' opinions about the conceptual change oriented instruction accompanied by analogies. Last question is asked only the experimental group students. Three students from the experimental group and three students from the control group were interviewed. Each interview with a student took approximately 30 minutes and interviews were recorded on a tape recorder.

4.5 Treatment

The study was conducted over three weeks during the Second Semester of 2010-2011. Two teaching methods were randomly assigned to the classes. Experimental and control groups were instructed by the same teacher. She has 10 years previous teaching experience of science and technology course. During the treatment, the chemical bond topic was covered as part of the regular classroom curriculum in the science course. The course of the regular schedules is four 40-minutes periods per week and this study was conducted three week. The topics covered were ionic bond and its properties, covalent bond and its properties, periodic table, group in periodic tables, ions.

At the beginning of the instruction, pre-CBCT were administered to the students in control and experimental groups in order to determine whether there was any difference between two groups with regard to understanding of chemical bond concepts prior to instruction. The Chemical Bond Concept Pre-Test (pre-CBCT) was prepared according to seven grade students' chemical bond knowledge. Also, ASTS was given to measure students' attitudes toward science as a school subject. Additionally, SPST was distributed to all students in the groups to assess their science process skills.

Lecture and discussion methods were used in the traditionally designed science instruction courses. Teaching methods was based on explanations, textbooks and questioning. Hence the misconceptions that students had been not took into account. Eaching strategy was based on teacher explanation. Defination, explanation and concepts were presented in the blackboard. Also teacher solved students' workbooks. Sometimes some of the students asked questions. The teacher answered the questions and directed new questions to explore whether the concept was understood. The teacher made explanations without considering the students' misconceptions.

The experimental group was taught under the conceptual change texts and texts accompanied with analogies. Texts were prepared by the researcher by searching for the related literature. Conceptual change texts identified the misconceptions about chemical bond concepts and correct them by giving analogies, examples, figures and sientific explanations. Scientific knowledge and explanations in the texts are intelligible and plausable. Thus, students were expected to be dissatisfied with their previous knowledge, and then they were corrected by using analogies, examples, figures and sientific explanations. Students activated to make a prediction about a situation. It was given some evidence that the misconceptions are incorrect. Then, it was provided to find the scientifically correct explanations. Before the treatment, the teacher was informed what the conceptual change oriented instruction accompanied by analogies is and how it can be used.

The instruction was based on conditions under which the students' misconceptions were activated and could be replaced with scientific conceptions and new conceptions could be incorporated with existing conceptions.

The lessons in the experimental class began with an inquiry questions to activate students' existing knowledge and misconceptions. The strategy used was based on Yager's (1991) constructivist teaching strategy. According to this strategy, as a first step (invitation), the teacher asked students some questions at the beginning of the instruction in order to activate prior knowledge of students and promote student-student interaction and agreement before presenting the concept. For example, the teacher began the lesson by asking which particle of the atom play a role in chemical bond. The aim was to activate the students' prior conceptions (misconceptions) about the concept. As a second step (step 2: exploration), students were allowed to discuss the question in groups by using their previous knowledge related to atoms. During discussions students realized that their own and other's thoughts, shared their ideas, defended their answers and reached a consensus about the question. Meanwhile, the teacher didn't interfere with the students. They constructed their tentative answers freely. Each group gave a common answer to the teacher after discussion. In this way, the teacher had an opportunity to view the students' previous ideas. Also, the students had cognitive conflict when their ideas were not adequate to answer the question the teacher asked. This situation supported the first condition of Posner et al.'s (1982) conceptual change model. Dissatisfaction was also promoted by the teacher in the next step. Based on their answers, he explained the concept. Discussion continued by showing to the students an atom model. Teacher describes from the atom model that proton and neutron do not move and electrons move. While the students looked at the model the teacher asked new question, where does the electron go while the chemical bond is occuring? A new discussion guided by the teacher began. Then a third step (step 3: proposing explanations and solutions) occurs when the students' got aware of their disagreement on the answer the teacher performed the analogy related to chemical bond. In this way, the teacher provided environment in which the students notice their misconceptions and see the correct answer (dissatisfaction). So, the students had opportunity to contrast their misconceptions with the scientifically correct knowledge. To advance the acquisition of the scientifically knowledge response the teacher asked new questions. What do you think what a chemical bond means? The purpose of the question is to activate students' existing ideas and identify their preconceptions. The students discuss the question and the teacher guides the students during the discussion. By this way students saw their existing ideas.

Discussion is important in terms of causing students to have cognitive conflict according to Posner et al.'s (1982) conceptual change model. During discussions, students became aware of their ideas and saw some inconsistencies or gaps in their reasoning and therefore dissatisfaction occurred. Based on their answers, she explained the concept. She identfied that we can not see chemical bonds with our eyes or we can not touch bonds with our hands. She emphasized on common misconceptions and the topics in which students had difficulty. She showed solar system picture and she used this analogy in order to make concepts more concrete. while explaining what a chemical bond was, he constructed similarities between magnets and bonds; the fact that that like poles repel each other and unlike poles attract each other is similar to the attraction and repulsion between electric charges. In this step, the teacher tried to accomplish Posner et al.'s (1982) conditions of intelligibility and plausibility by stressing on the students' preconceptions, making relationship between their conceptions and scientific knowledge and giving examples. Moreover, students saw usage of information they obtained in explaining other situations. Therefore, Posner et al.'s (1982) last condition (fruitfulness) was also achieved. Before presenting each new concept, the teacher asked questions which students could answer by using their previous knowledge (step 4: taking action). Some questions were: Why atoms make bond? What is the ionic bond? What is the covalent bond? How does occur octet rule? Why does table salt conduct electricity when dissolved in water? All of the questions reflected students' misconceptions found from literature. Yager's (1991) constructivist teaching strategy was used for each question as a circle. Appendix F summarizes the sample lessons based on this strategy.

However, the conceptual change texts and texts accompanied with analogies were given to 25 students in experimental group. Texts were prepared by the researcher by searching for the related literature. Conceptual change texts identified the misconceptions about chemical bonds and misconceptions were corrected by using analogies, scientific explanations, examples and figures. Then, students made predictions about the situations in the conceptual texts and they reached scientifically correct explanation (Posner at. al., 1982). Conceptual change text and analogies was applied in class hour. Conceptual change texts were prepared according to common misconceptions that students' have in the literature. Also activities related to concepts were used. For example; students discriminated the metals and nonmetals by using periodic table and they make chemical bonds by using these elements. For this activity teacher used yellow, blue and pink cards. These cards represent the metal, nonmetal and noble gas. It was written nonmetal on pink and it was written metals on yellow cards. It was written noble gas on blue cars. It was used periodic table which was prepared by the researcher. Students paste the pink and yellow, blue cards on periodic table. By making this, students learn the elements place in periodic table and discriminate metal and nonmetals. Then by using pink and yellow cards students make ionic bonds. Also, by using only pink cards students make covalent bonds. Another example is related to electron configuration. In this activity, students made electron configuration then they decide the element is metal or nonmetal or noble gas. In order to create meaningful learning the learning material which was made by the researcher was used. Students make elements' electron confuguration according to their atomic numuber. In the first tube, it was put two beads, In the second tube, it was put eight bead, In the thirdh tube, it was put eight bead. Then the students used this tool in order to make atom's electron confuguration according to their atomic numuber.

At the end of the treatment the Post Chemical Bonds Conception Test (CBCT) was used. Eight grade science and technology textbooks and questions used previously in the studies related to students' misconceptions regarding chemical bond were used in constructing the Chemical Bond Concept Post Test (post-CBCT). Also, in order to determine students' attitudes toward science as school subject (ASTS) was given to students after the implementation. ANCOVA was used to determine the effectiveness of two different instructional methods and it was used to determine the differences between the post test mean scores of the students in control group and traditional group with respect to their attitudes toward science as school subject.

4.6 Analogies

Analogies used within conceptual change oriented instruction aimed to cause conceptual conflict and dissatisfaction with the existing but incorrect conceptions in the students' minds. The analogies were presented in such way that students could see that they are wrong in their reasoning. Additionally, each of the analogies was designed to overcome particular misconceptions.

Analogies were presented in the accordance with the sequence of the topics. Following analogies were performed in the experimental group:

1. It was showed a model related to molecules of atom, molecules of compounds then students made molecules by using molecule models (coloured beads) which was given by the Ministry of Education.
2. It was used a tale related to structure of atom and ion then the questions related to tale is answered by the students. There were analogies in the tale. Related activities are done.
3. It was used analogy (solar system picture) for explaining chemical bond.
4. It was used analogy for ionic bond and covalent bond. Magnet pictures were used for analogy. The same poles of magnets repel each other but the unlike poles attract each other. Atoms are electrically charged, so that reason they attract or or repel like the poles of the magnets. Also, dogs picture were used for bond analogy. Then the tale which explain chemical bond was used and questions related to tale is answered by the students. Related actvities with chemical bond is done.

For the first analogy, the aim was to demostrate students that the atom and molecules difference. Also, students realize the difference of molecules in elements ad molecules in compounds.

For the second analogy, a tale related to atom and ions which was prepared by researcher was used. Questions related with the tale were asked to the students. Related activies is done by the students.

For the third analogy, students made a relation with planets in solar system and molecules in chemical bonds.

For the fourth analogy, the researcher used the pictures related to ionic and covalent bond. Magnet pictures are used. The same poles of magnets repel each other but the unlike poles attract each other. Atoms are electrically charged, so that reason they attract or or repel like the poles of the magnets. Also dog pictures are showed to the students. Then students make analogy with chemical bond and dogs situation. After that teacher used a tale which explain the chemical bond and place of elements in periodic table. Questions related with the tale were asked to the students. Related actvities with chemical bond is done by the students.

4.7 Data Analysis

4.7.1 Descriptive and Inferential Statistics Analyses

For the data obtained from the subjects in the experimental and control groups mean, standard deviation, skewness, kurtosis, range, minimum and maximum values, and charts were performed as descriptive statistics analyses. As inferential statistics Analysis of Covariance (ANCOVA) and Analysis of Variance (ANOVA) were performed to address the research questions of the study.

ANCOVA was used to determine effectiveness of two different instructional methods related to chemical bond concepts by controlling the effect of students' science process skills as a covariate. Additionally, this analysis revealed the contribution of science process skills to the variation in students' understanding. To test the effect of treatment and gender difference on students'attitudes toward science as a school subject two-way ANOVA was used.

4.7.2 Missing Data Analysis

Before the analysis of the data, missing data analysis was performed. Although the total of the students included in the treatment was 51 the final sample included in the data analysis consisted of 50 students. One student from the experimental group was excluded from the study because he was not at school on the date of the post-CBCT, so he did not participated to the post-CBCT. There was one missing data related to students' chemical bonds concept post-test scores. There was no missing data related to the science process skills test scores (SPST). and attitudes towards science (ASTS). The percentage of missing data of the Science it was less than 5 % of the whole data, the series mean of the entire subjects (SMEAN) was used to replace the missing data (Cohen and Cohen, 1983).

4.8 Assumptions of the Study

1. Experimental and control group students did not interact during treatment.
2. Students in both groups were sincere and accurate in answering questions in the instruments used in the study.
3. The teacher followed the researcher's instructions and was not biased during the treatment.
4. The CBCT, ASTS, and the SPST were administered under standard conditions.
5. The classroom observations were performed under standard conditions.

4.9 Limitations of the Study

1. This study was limited to the unit of chemical bonds.
2. This study was limited to eight grade students at a public elementary school in Ankara during the Spring Semester of 2010-2011.
3. The subject of the study limited to 50 students in two classrooms.

CHAPTER V

RESULTS AND CONCLUSIONS

In this chapter, the results obtained from the treatment are presented according to the hypothesis stated in Chapter three. Results of the study are presented under five headings; the results of the descriptive statistics related to the Chemical Bond Concept Test, Attitude Scale toward Science, the result of the study related to the inferential statistics of testing 6 null hypotheses, the results of interviews with students, and conclusions.

5.1 Descriptive statistics

Descriptive statistics related to the students' chemical bonds concept pre- and post-test scores, science attitudes pre- and post-test scores, and science process skills test scores in the control and experimental groups were conducted. The results were shown in Table 5.1. Students' chemical bond concept test scores range from 0 to 25. The higher scores mean the greater success and more understanding in chemical bonds. In table 5.1, the mean of the pre- CBCT is 13.56 and the post-CBCT is 20.72 in the experimental group, while the mean of the pre-CBCT is 12.88 and the post-CBCT is 14.76 in the control group. The mean score increase of 7.16 in the experimental group is higher than the mean score increase of 1.88 in the control group. The students in the experimental group were more successful and acquired more understanding in chemical bonds than students in the control group.

Students' attitudes scale toward science scores range from 15 to 75 with higher scores mean more positive attitudes toward science. In Table 5.1, mean of the pre-ASTS is 54.76 and the post-ASTS is 57.84 in the experimental group with mean score increase of 3.08. In the control group, the mean of the pre ASTS is 53.32 and the post-ASTS is 53.92 with mean score increase of 0.60.

Students' science process skills test scores range from 0 to 36 and greater scores indicate higher abilities in solving science problems. As shown in Table 5.1, the mean of SPST is 26.40 in the experimental group and 24.08 in the control group.

The Table 5.1 also shows some other descriptive statistics as range, minimum, maximum, standard deviation, skewness, and kurtosis values. The skewness of the pre-CBCT was -.866 and the post-CBCT was -.486 in the experimental group, while the skewness of the pre-CBCT was .406 and the post- CBCT was .04 in the control group. The skewness values of the pre-and post-ASTS were -.650 and -.018 in the experimental group, and -.228 and -.705 in the control group, respectively. The kurtosis values are also shown in Table 5.1. The skewness and kurtosis values near to 0 indicate the normal distribution of the variables. In this study, the distribution of the variables can be accepted as normal.

Table 5.1 Descriptive Statistics Related to Chemical Bond Concept Test (CBCT), The Attitude Scale toward Science (ASTS), Science Process Skill Test (SPST).

GROUP		DESCRIPTIVE STATISITICS							
		N	Range	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
EG	Pre-CBCT	25	7	10	17	13.56	2.84	-.866	.007
	Post-CBCT	25	10	15	25	20.72	2.79	-.486	-.511
	Pre-ASTS	25	25	40	64	54.76	5.67	-.650	.412
	Post-ASTS	25	32	42	74	57.84	8.23	-.018	-.995
	SPST	25	13	20	33	26.40	3.43	0.81	-.453
CG	Pre-CBCT	25	10	10	20	12.88	2.62	.406	.907
	Post-CBCT	25	12	9	21	14.76	3.22	.040	-1.03
	Pre-ASTS	25	15	45	60	53.32	4.23	-.228	-.939
	Post-ASTS	25	22	48	70	53.92	5.36	-.725	.503
	SPST	25	13	17	32	24.8	4.43	-.057	-1.183

5.2 Inferential Statistics

This section presents the results of analyses of 6 null hypotheses stated in chapter III. The hypotheses were tested at a significance level of .05. Analysis of covariance (ANCOVA) and analysis of variance (ANOVA) were used to test the hypotheses. In this study, statistical analyses were carried out by using the SPSS/PC (Statistical Package for Social Sciences for Personal Computers).

Independent samples t-test analyses was used in order to examine if there is a significant difference at the beginning of the treatment between the CCIA group and TDSI group in terms of students' understanding of chemical bond concepts. The results of independent samples t-test analyses showed that there was no significant difference at the beginning of the treatment between the CCIA group and TDSI group in terms of students' understanding of chemical bond concepts. It is measured by pre-CBCT (t (48) = .879, p = .384), and students' attitudes toward science measured by pre-ASTS (t (48) = .943, p = .351). Also, there is no significant difference was found between the two groups with respect to science process skills (t (48) = 1.451, p=.153).

Table 5.2 (Independent t-test of pre CBCT for the control and experimental group)

Levene test

F	sig	t	df	sig. Two tail	mean dif	std eror	confidence int(lower-uper)	
.152	.699	. 879	48	. 384	.68	.7733	-.87483	2,23483
		.879	47.67	.384	. 68	.7733	-.87511	2,23511

Table 5.3 (Independent t-test of pre ASTS for the control and experimental group)

F	sig	t	df	sig. Two tail	mean dif	std eror	confidence int(lower-uper)	
.059	.809	.943	48	.351	1.44	1.52753	-1.63133	4.51130
		.943	47.514	.351	1.44	1.52753	-1.63210	4.51210

5.2.1 Null Hypothesis 1

The first hypothesis stated that there is no significant difference between the post-test mean scores of the students taught with conceptual change oriented instruction and students taught with traditionally designed science instruction with respect to understanding chemical bond concepts when science process skills is controlled as a covariate. To test hypothesis 1 analysis of covariance (ANCOVA) was conducted. The results are summarized in Table 5.4.

Table 5.4 ANCOVA Summary (Understanding)

Source	df	SS	MS	F	p
Covariate (Science Process Skills)	1	137,309	137,309	27,634	,000
Treatment	1	332,199.	332,199	58,740	,000
Gender	1	,831	,831	.147	,703
Treatment*Gender	1	11,120	11,120	1,966	,168
Error	45	254,494	5,655		

The result showed that there was a significant difference between post-test mean scores of the students taught by CCIA and those taught by TDSI with respect to the understanding of chemical bond concepts, F (1, 45) = 58.740, MSE = 5.655, $p < .001$. When SPS is controlled, the CCIA group scored significantly higher than TI group (X(CCIA) =20.72, X(TI) = 14.76).

Figure 5.1 shows the proportions of correct responses to the questions in the post-CBCT for two groups. As seen in the Figure 5.3 there was a difference in the proportion of correct responses between the two groups to the questions in the CBCT. Remarkable differences were observed in the students' answers to the questions 1, 4, 5, 6, 7, 12, 14, and 17, 18, 19, 22.

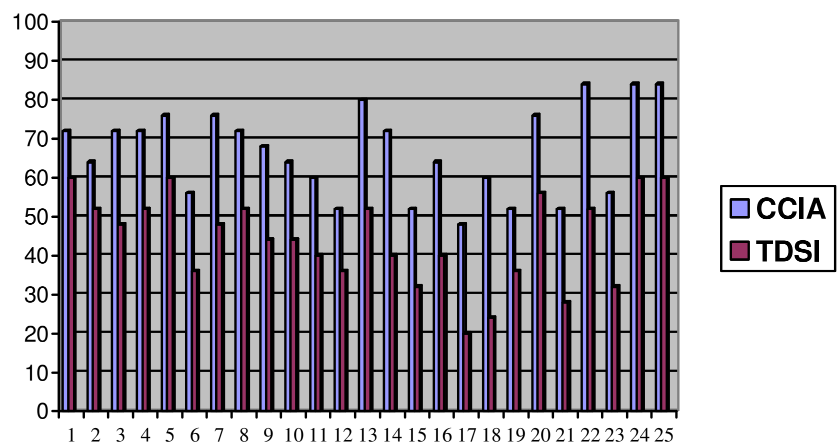

Figure 5.1 Comparison between post-CBCT scores of the CCIA group and the TDSI group

In the first question there were given In question 1, students were asked to select which information is true for the properties of chemical bond. After the treatment, in the experimental group 74 % of the students gave correct answer to the question. In the control group, 60% of the students answered the question correctly. As expected, the misconception held by the students in both groups was that to confuse ionic and chemical bond properties.

Question 4 tested to find chemical bond type acording to elements atomic number. The majority of the students in experimental group gave correct answer to the question. In the control group, 52% of the students answered the question correctly. In the experimental group, 72 % of the students answered correctly. Among experimental group students the common misconception was that ametal and metal makes covalent bond. (6.1%).

Question 5 tested the properties of chemical bonds. The majority of the students in experimental group gave correct answer to the question. In the control group, 60 % of the students answered correctly. In the experimental group, 72 % of the students answered correctly. Among the both group students the common misconception was that all atoms make chemical bond.

Question 6 in the test were related to metal and nonmetal's role in ionic and covalent bond. The majority of the students in control group gave wrong answer to the question. In the control group, 36 % of the students, in the experimental group, 56 % of the students gave correct answer.

Question 7 was related to distinction of ionic and covalent bond according to shapes of molecules. Remarkable difference was observed in the proportion of students' correct answers to the question 7 in two groups after treatment. In the control group, 44% of the students, in the experimental group, 72% of the students gave correct answer.

Question 12 was related to determine covalent bond in compounds. Most of the students in control group did not determine the bond type the compounds. In the control group, 36 % of the students, in the experimental group, 52 % of the students gave correct answer.

Question 14 tested the properties of chemical bonds. Remarkable difference was observed in the proportion of students' correct answers in this question for two groups. In the control group, 40 % of the students, in the experimental group, 72 % of the students gave correct answer.

Question 17 was related to determine chemical bond type according to number of electrons of antom and atomic number of given elements. Most of the students in both groups gave wrong answer to this question. In the control group, 20 % of the students, in the experimental group, 48 % of the students gave correct answer.

Question 18 was related to distinction of ionic and covalent bond according to shapes of molecules. In the control group, 24% of the students, in the experimental group, 60% of the students gave correct answer. Students in control group had difficulties when realizing the shape of ionic and covalent compounds.

Question 19 was related to distinction of ionic and covalent bond according to number of electron in last shell for the related atom. In the control group, 36% of the students, in the experimental group, 52% of the students gave correct answer.

Question 22 was related to particles of ionic and covalant compounds and kind of chemical bonds. Most of the students in both groups gave true answer to this question. In the control group, 52% of the students, in the experimental group, 84% of the students gave correct answer.

Correct answers of the pre test and post test score of the students in experimental group are given in figure 5.2 It was seen that there are significant difference between the pre test and post test score after the treatment.

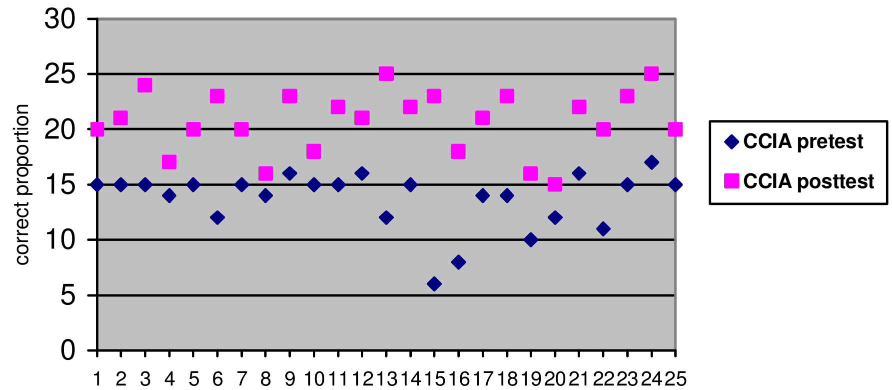

Figure 5.2 Correct answer scores for pre-CBCT and post-CBCT in the CCIA group.

Correct answers of the pre test and post test score of the students in control group are given in figure 5.3.It was seen that there is no significant difference between the pre test and post test score after the chemical bond instruction.

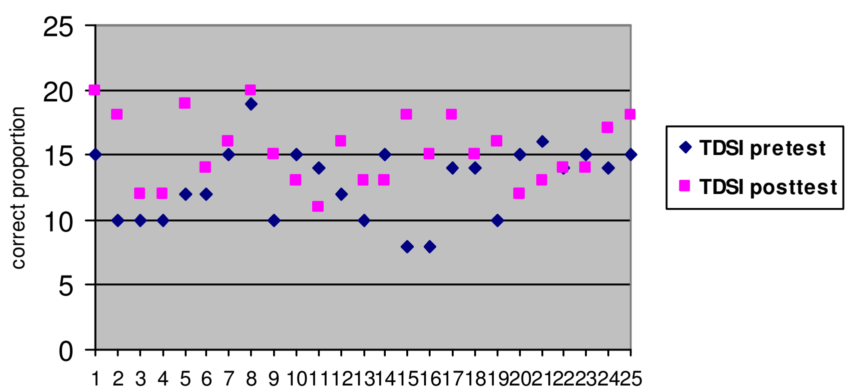

Figure 5.3 Correct answer scores for pre-CBCT and post-CBCT in the TDSI group.

5.2.2 Null Hypothesis 2

To answer the question posed by hypothesis 2 which states that there is no significant difference between post-test mean scores of females and males with respect to understanding of chemical bond concepts when the effect of students' science process skills is controlled, analysis of covariance was used. Table 5.2 also gives the effect of gender difference on students' understanding of chemical bond concepts. The results showed that there was no significant mean difference between female and male students with respect to understanding chemical bond concepts, $F(1, 45) = .147$, $MSE = .831$, $p = .703$. The mean post-test scores were 18.48 for females and 17.11 for males.

5.2.3 Null Hypothesis 3

To test hypothesis 3 stating that there is no significant effect of interaction between treatment and gender on students' understanding of chemical bond concepts when the effect of science process skills is controlled as a covariate, analysis of covariance (ANCOVA) was run. Table 5.2 also gives the interaction effect on understanding of chemical bond concepts. The findings showed that there was no significant interaction effect between gender and treatment on students' understanding of chemical bond concepts, $F(1, 45) = 1.966$, $MSE = 11.120$, $p = .168$.

5.2.4 Null Hypothesis 4

To test hypothesis 4 which states that there is no significant contribution of students' science process skills to understanding of chemical bond concepts, analyses of covariance (ANCOVA) was used. The results indicated that there was a significant contribution of science process skills on students' understanding of chemical bond concepts, $F(1, 45) = 27.634$, $MSE = 5.655$, $p = .000$.

5.2.5 Null Hypothesis 5

The null hypothesis 5 stated that there is no significant mean difference between students taught with conceptual change oriented instruction and traditionally designed science instruction with respect to their attitudes toward science as a school subject. In order to test the hypothesis two-way analysis of variance (ANOVA) was performed. Table 5.4 summarizes the results of this analysis.

Table 5.5 ANOVA Summary (Attitude)

Source	df	SS	MS	F	p
Treatment	3	213.852	213.852	6.829	.000
Gender	1	3.583	3.583	.114	.737
Treatment*Gender	1	35.013	35.013	1.118	.296
Error	46	1440.46	31.314		

The results showed that there was significant mean difference between students taught through conceptual change oriented instruction and traditionally designed science instruction with respect to attitudes toward science as a school subject, F (1, 46) =6.829, p = .000. Students instructed by instruction based on conceptual change oriented instruction had more positive attitudes (X=57.84) than students having traditionally designed science instruction (X=53.92).

5.2.6 Null Hypothesis 6

In order to test the hypothesis 6 stating that there is no significant difference between post-attitude mean scores of females and males, two-way analyisis of variance (ANOVA) was carried out. Table 5.4 shows the effect of gender difference on students' attitudes. The results indicated that there was no significant mean difference between female and male students with respect to their attitudes toward science as a school subject, F (1, 46) = .114, p = .737 (p >0.05). Female students' mean score was 53.80 and male students' mean score was 53.94.

5.3 The Interviews

Interview method allows learners' to discuss their reactions toward instruction in more detail than can be done on a survey or questionnaire. Interview method is usefull in order to determine students' ideas in science.

The general aim of interviewing is to find out what someone knows about the related issue. Interview sessions were conducted wth six students from the experimental and the control groups. Students are choosen according to their CBCT result. For both experimental and control group, one of the student was choosen among the students who have 20-25 true answer and one of the student was choosen among students who have 14-19 true answer and one of the student was choosen among the students who have 1-14 true answer. Students were randomly selected from this group.

In this study, the students were interviewed on questions related to 1) defining chemical bond 2) defining ionic bond and explaining ionic bond's properties, 3) defining covalent bond and explaining covalent bond's properties 4) particles of ionic compounds 5) particles of covalent compounds 6) drawing an example for ionic and covalent compounds 7) last question was asked to take students' opinions about the conceptual change oriented instruction accompanied by analogies. During transcription, students were given numbers to prevent any confusion. Students with odd numbers were experimental group students, while the students with even number were control group students. The interviews conducted with the students are presented below:

Question: Can you explain chemical bond?
Student 1: This is a force that holds atoms together in compounds or in molecules. This is a force like planets have in solar system. Anddd..There are two kind of bond. One of them is covalent bond and other one of them is ionic bond.

Student 3: Chemical bonds are a force that holds atoms and molecules. Compounds have chemical bonds and molecular elements have chemical bond. But atomic elements have not chemical bond.

Student 5: This bond which compounds and molecular elements have. It holds atoms in compounds or in molecules.

Students in the experimental group explained chemical bond successfully. One of them is used analogy that teacher used in instruction.

Student 2: Atoms apply a force to each other like a magnet. That is chemical bond.

Student 4: This is a force which holds molecules. Bonding occurs between the electrons.

Student 6: This is a chemical thing which elements or compounds have. Especially lifeless matter has chemical bond.

Students in control group have partial understanding of chemical bond and they have misconceptions in this concept.

Question 2: Can you define ionic bond and its properties and can you give examples?
Student1: Metal and nonmetal makes ionic bond. Metal gives elektron like magnesium and nonmetal takes elektrons like clor while making ionic bond. Thus, electron transfer occurs between atoms. I think, Ionic bond is very strong bond.

Student 3: Anyon and catyon makes ionic bond. Anyon takes electrons and catyon gives electrons by this way ionic bond occurs between metal and nonmetal. For example K is the positive one and then Cl is the negative one and in KCl compound K gives electron and Cl takes electron.

Student 5: Ionic bond occurs when electron is transferred between metals and ametals. For example NaCl, it has ionic bond because Na is metal and Cl is nonmetal.

Students in experimental group explain the ionic bond and its properties more detailed than the students in control group.

Student 2: When elektron transfer occurs between atoms, ionic bond occurs. Anyon takes electrons and catyon gives electrons.Hmmm….for example Na and Cl I think.

Student 4: Anyon and catyon gives electrons to each other thus ionic bond occurs. I think..Na, K or F, O can make ionic bond with each other.

Student 6: Ions are tied to other ions and ionic bond occurs. But I don't remember the example.

The students' incorrect answers were due to the common misconception that anyon and catyon gives electron in ionic bond. The students had partial understanding about the ionic bond and its properties. Also they have difficulties while they were giving examples.

Question 3: Can you define covalent bond and its properties and can you give examples?

Student 1: Nonmetal atoms always want give electrons when they are making a compound. Thus, they are shared one or two or three electrons.Then the covalent bond occurs between the nonmetals' atoms. For example Flor and flor or clor and clor have covalent bond which is apolar colvalent bond and different nonmetal like carbon and oxygen has polar covalent bond. These are the kind of covalent bond.

Student 3: Covalent bond occurs between the anyon and anyon. They are shared electron on their last shell. I can give some example, SO_2, CO_2, Br_2 ,I_2 *like..*

Student 5: I think.. Covalent bond occurs between metal and nonmetal or nonmetal and nonmetal. These atoms share electrons, while they are making bond.

In experimental group, answers of student1 and student3 are correct and they explain the question succesfully. But answer of student 5 is incorrect. He/she have common misconception that the Covalent bond occurs between metal and ametal.

Student2: Negative ions come together and they share electrons thus covalent bond occurs. For example O-O, I-I or FCl.

Student4:This is a bond which metal and nonmetal make. I think this bond is very strong than the ionic bond. It involves complete electron transfer. For example, In the compounds of FCl, flor gives one elctron to the clor atom.

Student6: This is a bond which makes only metals. It holds atoms together and metals share electrons, while forming bond. For example K-K can make covalent bond.

In control group, answer of student 2 is correct but answer of student 4 and student 6 are incorrect. These students have misconceptions while explaining covalent bond they confuse with the covalent bond and properties.

Question 4: Which one of the followings does not make up chemical bonds each others (metals, nonmetals and noble gas)?

Student 1: Noble gases never do chemical bond with another group. Also, metal and metal do not make chemical bond. They make only mixture with eachother. But metal and nonmetal make bond and their bond is called ionic bond like NaCl.

Student 3: noble gas-metal, noble gas -noble gas and metal-metal do not make chemical bond with each other. Hmm.. I remember the tale I think only the nonmetal make bond with metal. But also they make bond with each other.

Student 5: Except noble gas, other group makes chemical bond. But metals do not make bond with each other.

Students in experimental group answered the question correctly. But students in control group have some misconceptions on chemical bond.

Student 2: I think noble gas and metals do not make chemical bond. But ametal makes bond with metal and nonmetals.

Student 4: Sometimes, all of the group make bond and sometimes they do not make bond with each other. Hmm.. They make bond if they are appropriate condition. Sometimies some elements want to take electron and sometimes they want give electrons.

Student 6: Only the group of noble gas does not make chemical bond. But the other make bond with each other or between themselves. They always make bonds with each other.

Question 5: What are the particles of ionic compounds?
Student 1: These are anyon and catyons.

Student 3: These are ions which the name of anyon and catyon.

Student 5: The particles of ionic compounds are ions.

Students in experimental group answered the question correctly. They understand the particles of ionic compounds at molecular level.

Student 2: I think these are ions which are indicating positive and negative symbols.

Student 4: The particles of ionic compound are atom and molecule.So, ionic compounds are molecular in nature.

Student 6: All of the compounds particles are atoms. Because, matters have atoms.

Students in control group had partial understanding about the particles of ionic compound. They have misconceptions on the concept of atom and ion.

Question 6: What are the particles of covalent compounds?

Student 1: The particles of covalent compounds are molecules.

Student 3: These are molecules and atoms.

Student 5: These are only molecules not ions.

In experimental group answer of student1 and student5 are correct but answer of student3 is not correct, exactly. Because, he/she identified that it is atom. He/she confused that compound and elements properties.

Student 2: Their particles are molecules.

Student 4: The particles of covalent compounds are atom or ions.

Student 6: They have atoms because all of the things in world have atoms.

Students in control group have misconceptions on the particles of covalent compounds. Also, they have misconception on the concept of atom and molecule. The students both in experimental and the control group thought that particles of covalent compounds are atom because it is a matter and matter consist atoms.

Question 7: Can you draw an example for ionic and covalent compound?

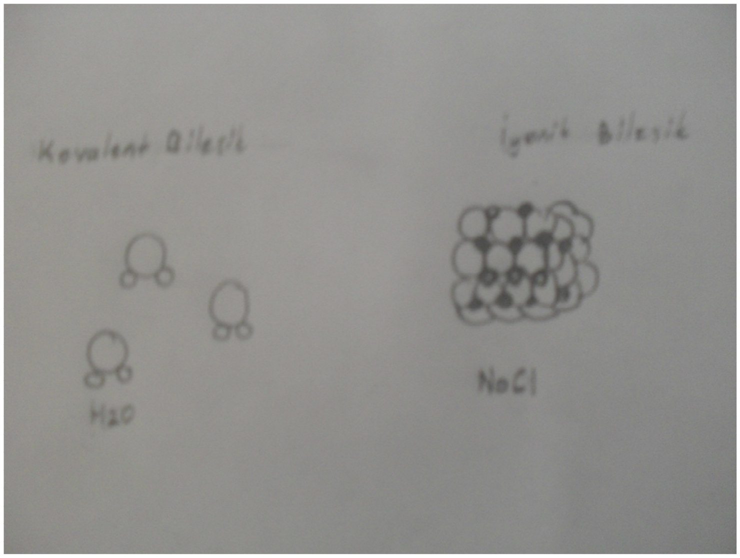

Figure 5.4 Drawing of Student 1

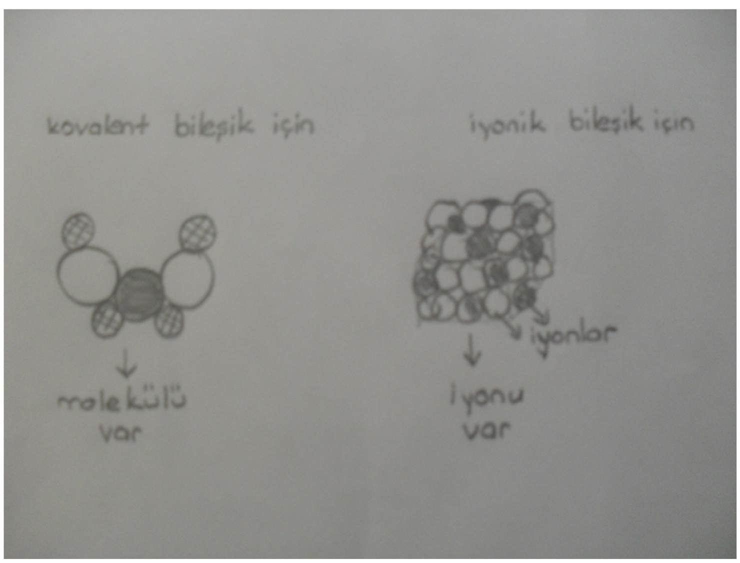

Figure 5.5 Drawing of Student 3

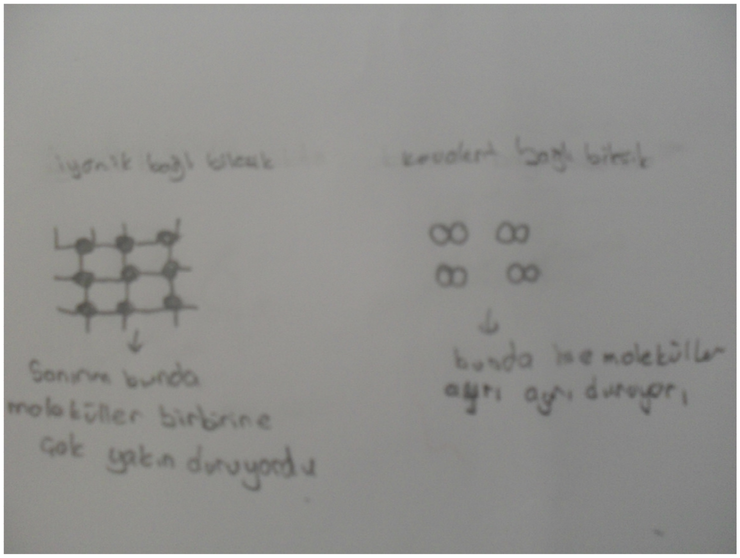

Figure 5.6 Drawing of Student 5

Students in experimental group give correct answers for the seven questions. Students in control group give incorrect answers and they have partial understanding for ionic and covalent compound drawings.

Figure 5.7 Drawing of Student 2

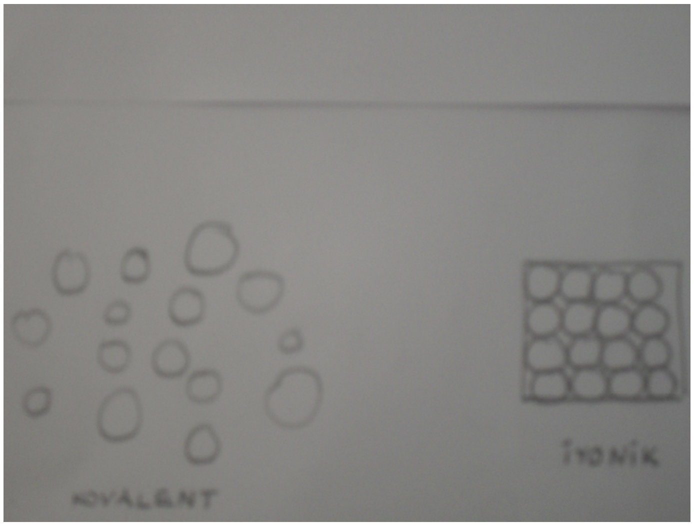

Figure 5.8 Drawing of Student 4

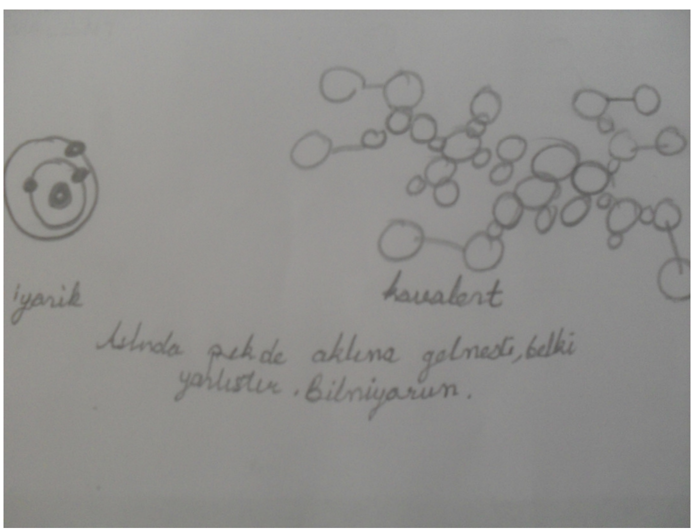

Figure 5.9 Drawing of Student 6

Question8: What do you think about learning the chemical bond with the new method?

Student1: In this method we can make discussing. By this way, we shared our ideas with other students. Analogies helped me to understand the concept more detailed. Also I make link between the concept and the analogies, thus I learned the concepts quickly.

Student3: I liked conceptual change and analogy. Because I learned the chemical bonds more detailed and I memorized the concepts easily, when I was making the test. Also, I remembered the analogies then I remembered the concepts when I was making test.

Student5: I don't like only the textbook instruction. Because, I'm boring while teacher using traditional instruction. I like laboratory activities, demostrations and analogies. Analogies were very useful and helped me to understand beter the texts in the science and technology textbook.

Most students liked the method that used the study. Also most students explained that they liked discussing because they felt happy to share all ideas that they thing.
Some of the students in the experimental group still process misconceptions. Although most of the students in this group eliminate their misconceptions during the treatment, students in control group have different type misconceptions related to chemical bonds.

5.4 Conclusion

In the light of the findings which obtained by the statistical analyses, the followings can be deduced:

1. The conceptual change oriented instruction accompanied by analogies caused a significantly better acquisition of scientific conceptions related to chemical

bond and elimination of misconceptions than traditionaly designed science instruction.

2. Science process skills had a contribution to the students' understanding of chemical bond concepts.

3. There was no significant effect of gender on the students' understanding of chemical bond concepts and their attitudes towards science as a school subject.

4. The conceptual change oriented instruction accompanied by analogies and traditionally designed science instruction produced statistically the same attitudes towards science as a school subject.

5. Both CCIA and TDSI groups improved their understanding. So, it can be drawn that the growth in understanding of chemical bond concepts is statistically significant, but the growth was higher in CCIA group.

6. There was no significant effect of interaction between gender and treatment in students' achievement related to chemical bond concepts.

7. In both groups, boys and girls were equal after treatment with respect to their attitude toward science as a school subject.

8. There was no significant effect of interaction between treatment and gender difference on students' attitude s toward science as a school subject.

CHAPTER VI

DISCUSSION, IMPLICATION AND RECOMMENDATION

6.1 Discussion

The purpose of the study was to investigate the effectiveness of conceptual change oriented instruction accompanied with analogies on eight grade students' understanding of chemical bond concepts and attitudes towards science as a school subject.

As mentioned earlier, chemical bond concepts pre-test was administered to both groups before treatment as a pretest. Pretest result indicated that there was no significant differences between the pretest mean scores of two groups. Therefore, it can be said that both groups were equivalent with respect to their understanding of chemical bond concepts before the treatment. After the treatment, post test was given to all students in both groups to examine the effects of two different instructional methods on understanding of chemical bond concepts. CBCT post-test result showed that students in the experimental group got higher scores than the students in traditional group. Based on the statistical analyses results given in chapter V, it can be concluded that conceptual change oriented instruction accompanied with analogies caused a significantly better acquisition of scientific conceptions related to chemical bond and remediation of misconceptions than traditionaly designed science instruction. Hovewer, both treatment and gender did not cause any significant increase in students' attitudes towards science as school subject.

In this study, chemical topic is studied, which includes concepts difficult to be grasped because or their abstract nature. Chemical bonding concepts are abstract bacause; students cannot see an atom or interactions between atoms or other elementary particles (Griffiths & Preston, 1999). So that reason, students are faced with difficulties and also they have some misconceptions about the chemical bonding. The science and technology teachers should be aware of their students' ideas about scientific phenomena prior to instruction and arrange the instructional sequence in such a way to make students be aware of their pre knowledge. Also, the teachers should be give opportunity to their students in order to explain their ideas in class and should be give opportunity to discuss their ideas either with the teacher or with their friends. By this way, students realize their ideas are incorrect. Then, the teacher has to provide more evidences to show that their ideas are incorrect. By the time, the teacher should give the correct and scientific conception by making the concept concrete and understandable for the students.

According to constructivist learning theory if the students construct their own knowledge actively, their understanding will be enhance comparatively passively learning (Posner, Strike Hewson and Gertzog, 1982). So constructivist teaching strategies and conceptual change approach are powerful tools to elimnate misconceptions (Novick and Nussbaum, 1982; Posner et al., 1982; Hewson and Hewson, 1983; Yager, 1991). This study produced similar findings with other research studies arguing that the conceptual change approach is an effective tool improving students' understanding of scientific concepts. Novick and Nussbaum (1982) used conceptual change discussion method to eliminate students' misconceptions related to the particulate nature of the matter. The results of the study showed that the conceptual change discussion method was effective in improving students' understanding of the particulate nature of the matter. Furthermore, Papuçcu and Geban (2006) explored the effects of conceptual change texts oriented instruction on ninth grade students' understanding of chemical bonding concepts. The result showed that the conceptual change texts and discussion were effective in remedying the students' misconception in chemical bonding concepts. Bayır (2000) stated that conceptual change text instruction in chemical change and conservation of mass concepts was effective on students' understanding of the concepts. Bayır (2000) also showed that there was no statistically significant difference between male and female students with respect to success related to chemical change and conservation of mass concepts after the treatment. Similarly, Andre and Chambers (1997) investigated the relationship between gender, interest and experience in electricity, and use of conceptual change text on learning electric circuit concept. They found that conceptual change text more effective than the traditional text in conceptual understanding of electric circuit concept and there was no statistically significant difference between male and female students with respect to achievment related to electric circuit concept.

The students in the experimental group were taught by chemical bond conceptual change texts created conceptual conflict by explaining why students' intuitive ideas were incorrect and also scientifically correct explanation of the phenomena was presented in the texts. These texts activated students' misconception and provided opportunity for students to revise and reconstruct their ideas about the scientific phenomena by refuting the alternative conceptions. Conceptual change texts were also powered with analogies. Because of the abstract nature of the chemical bond concepts, most of the students cannot relate their previous knowledge to new knowledge during instruction (Bodner, 1991; Nakhleh, 1992). Analogies provide special learning environment by using target concepts with the help of the analogs that are known. By this way meaningful learning occurs in students' mind (Glynn, 1997; Beall, 1999). Firstly, the teacher determined the students' alternative conceptions by asking questions. Students were encouraged to discuss and share their ideas and students became activated in the classroom. Discussion guided by the teacher went on until they became aware of the fact that their different ideas. Instruction continued with performing an analogy and conceptual change text in order to give students opportunity to contrast the alternative conceptions with scientifically correct conception. Students noticed that their prior knowledge were not useful and sufficient in explaining the scientific phenomenon.

Both discussions and analogies helped students to criticize their thinking. In order to improve the acquisition of the scientifically correct answer the teacher asked new questions, then gave examples from daily life situations as much as possible to improve understanding. The teacher focused on students' misconceptions and explained why these ideas were wrong. After the explanation, students were satisfied and they realized that new conceptions were more effective in explaining the situations and their intuitive ideas are inadequate to explain the descriptive events.The lesson finished with a question requiring further investigation on the newly learned concept. During this process, there was a close interaction between the teacher and the students. The teacher guided the discussion that could facilitate the meaningful and conceptual learning. The discussion environment caused dissatisfaction and reconstructing the prior knowledge and acquisition the scientific knowledge. In the experimental group both teacher and students were actively involved in teaching-learning process. The study showed that activating students' prior knowledge and refuting their misconceptions led to enhance their understanding of conceptions and their achievment. When conceptual change texts were used as a teaching strategy it is important to give enough time for students to think about their prior conceptions.

In the control group where traditionally designed science instruction was used, the science class sessions were based on the teacher explanation of scientific phenomena, logical represeantation of knowledge, some examples given in the textbooks. Students in control group were passive; they listened to their teacher and took notes. Students' participation was limited dur ing instruction. In other words, they were passive listeners during study. The teacher asked questions, then explained the correct answers but did not consider the students' prior knowledge and did not make efforts to correct the misconceptions. However, the students in the control group were not aware of their conceptions, neither scientific nor misconceptions. This may be the one reason why students in the control group got poor result in CBCT. Consequently, Students' conceptual understanding was weaker in control group than the experimental group students. Items in the CBCT were prepared for students to make prediction about the natural phenomena. But traditionally designed science instruction did not make any contribution to students' conceptual understanding. A reason for the better concept acquisition in the experimental group can be the continuous process of exchange and differentiation of the existing concepts and the integration of new conceptions with existing conceptions. Whereas, the control group students added the scientific conceptions to their conceptual framework which was full of alternative conception.

Chemical bond concepts pre test was administered to both groups before treatment. In this study pre tst and post test are different. Pre test was prepared according to students' seven grade chemical bond and periodic table knowledge. This test contains basic chemical bond concept knowledge and periodic table knowledge. Pretest result indicated that there was no significant differences between the pretest mean scores of two groups. Therefore, it can be said that both groups were equivalent with respect to their understanding of chemical bond concepts before the treatment. After treatment, post test was given to all students in both groups to examine the effects of two different instructional methods on understanding of chemical bond concepts. CBCT post-test result showed that students in the experimental group got higher scores than the students in control group. In the light of the result of the analysis, it may be concluded that conceptual change texts oriented instruction accompanied with analogies was more effective in elimination of misconceptions and better acquisition of scientific conceptions than traditionally designed science instruction.

When the results of CBCT post-test scores were compared, average correct response of experimental group was % 80 and the control group was %60. The differences of the experimental group post-test scores may be result of the treatment difference. The result of the study is supported by findings of Beeth (1997), Andre and Chamber (1997), Papuçcu and Geban (2006). Conceptual change instruction was more effective method when it was compared to traditional method. Students in experimental group got higher scores than the students in control group, because they engaged conceptual change texts. These texts were helped students to think about their prior knowledge. By this way students realize their misconceptions about the chemical bond concepts. Another reason may be the usage of interesting analogies. Analogies are helpful to teach abstract and complex science concepts that students often face difficulties. But in control group, students were instructed with teacher explanations and textbooks. Teacher did not consider the students' prior knowledge and did not make efforts to correct the misconceptions consider students' misconceptions. So, while students in experimental group became dissatisfied with their prior knowledge and thought about these ideas and willing to accept scientifically correct explanation of the phenomena. But, students in the control group showed a little improvement about clarifying misconceptions related with chemical bond concepts.

When we examined the result of the CBCT for both of groups, the analysis indicated that there was no significant difference between girl and boys with respect to their understanding of chemical bond concepts. Reason of this result may be that girl and boys in both groups engaged same teaching material and all the condition was the same for girls and boys.   This study was led to determination and identification of students' misconceptions about the chemical bond concepts.

This study showed that the conceptual change oriented instruction was effective than the traditionally designed instruction and supported the findings of the previous literature. However, the conceptual change instruction did not enhance significantly students' attitudes toward science as scholl subject.) As stated before, attitude toward science as a school subject was applied to all students in both groups before treatment as a pretest. ASTS pretest result showed that there was no significant difference between the mean scores of experimental group and control group in terms of attitude toward science as a school subject. After treatment, ASTS was administered to both groups as a post-test. And ASTS post-test result indicated that there was no significant difference between the post-test mean scored of experimental group and control group. The conceptual change oriented instruction accompanied by analogies provided students learning environment in which they had opportunity to exchange their prior ideas and to discuss these conceptions. Also, the interviews showed that students liked this method and analogies. Since the treatment was effective in increasing the students' understanding of chemical bond concepts and enhanced students' interest there should be another reason of no change in attitude.

Additionally, gender difference was not effective in students' attitudes toward science. Similar results were reported by Seker (2006). She investigated the effectiveness of conceptual change approach on students' achievement of atom, molecule, and matter concepts. The treatment was effective alone in increasing students' achievement, but treatment and gender were found that no effective in changing students' attitudes toward science significantly. Ceylan (2004) found that the chemical reaction and energy instruction did not improve students' attitudes toward chemistry and gender did not differentiate students with respect to attitudes toward chemistry. Also, Günay (2005) reported that the conceptual change oriented instruction accompanied with analogies was effective on tenth grade students' understanding of atom and molecule concepts but no effective in increasing attitudes toward chemistry.

On the other hand, some of the researchers found that gender difference affect the science experience, significantly. Jones, Howe, and Rua (2000) stated that significant gender difference with respect to science experiences, perceptions of science courses, attitudes and careers. Conceptual change text instruction was adminstered to students a three week period. This is short time to change students' attitudes toward science. In order to have more positive attitude, the new method may need to be used for more lenght time period.

Science process skills test was given to all students who participated to the study to examine its effect on their understanding of chemical bond concepts. The result of the analysis indicated that science process skills accounted for significant portions of variation on understanding of chemical bond concepts. In the light of the result, it may be concluded that science process skills is a significant predictor of the science achievement. There was a significant relationship between science process skills and students' understanding of the chemical bond concepts. The results showed that the groups are significantly different in terms of science process skills. Therefore, this variable was controlled as a covariate.

As a result, the present study showed that conceptual change texts oriented instruction accompanied with analogies led to better understanding of chemical bond concepts, and also better in elimination of students' misconceptions than the traditional science instruction. Students had difficulties in understanding chemical bond concepts and held misconceptions. The conceptual change approach promotes students' understanding of scientific concept. Conceptual change texts activate students' prior knowledge and they help to integrate students' prior knowledge and new conceptions. By this way, they enhance students' meaningful learning in science. The results of the study provided further proof about the literature related with students' misconceptions in science. In summary, this research also indicated that conceptual change texts and discussion about the texts address the students' misconceptions. Conceptual change texts oriented instruction accompanied with analogies provides alternative strategy to clarify students' misconceptions in science concepts.

6.2 Implications

The implications of the present study are:

1. Learning involves an interaction between new and existing conceptions. Coceptual change approach facilitates the integration of the prior and new knowledge. If the cognitive structure of the learner's preexisting knowledge has relevant ideas, meaningful learning occurs. Therefore, students should have mastered basic ideas first and then should learn more complex ones. They should be given the opportunity to express and share theirideas. If the students have no relevant ideas, they would try to make the new conception meaningful by interpreting it from their own point of view. Changing students' prior knowledge to new and plausible knowledge would be the matter of a well-designed conceptual change based instruction. The constructivist approach is important in terms of encouraging students to think about the scientific concepts and their conceptions.

2. Students should be aware of their prior knowledge. Conceptual change based instruction makes students aware of their prior knowledge. Also, discussions provide environment in which students explain their ideas. The results of the post-CBCT indicated that the students have the same misconceptions with those previously found in different research studies. All of the students in the world where live or taught, they have misconceptions. If the teacher activates students' prior knowledge and refutes their misconceptions, students' understanding of conceptions and their achievment may be enhanced. Teacher guides the discussion environment and students reveal their ideas. So, the benefits of the discussions become superior.

3. In the conceptual change oriented instruction accompanied with analogies, the analogies help to create cognitive conflict in students' mind. The cognitive conflict is important because students realize their prior knowledge had and they found the new conceptions are plausible and change their existing knowledge with the scientific knowledge. Analogies are helpful to teach abstract and complex science concepts that students often face difficulties. Additionally, analogies help the teacher to attract students' attention to the topic. Thus, the relation between new understandings and the real world motivates students to leam more. Teachers should design their instruction to facilitate conceptual change. They should determine students' prior knowledge and understand how students learn scientific concepts. They should make students realize their conceptions since a change in students' ideas is under their own control. The role of the teacher is to facilitate and support their thinking for conceptual change. The teachers should use effective instructional strategies to identify and eliminate misconceptions. Small group discussions are effective for conceptual change.

3. Science and Technology textbooks, as a main source of the knowledge. These books could be revised and designed to introduce the topics based on the conceptual change conditions.

4. Science and Tecnology curriculum should be designed on conceptual change conditions.

5. Misconceptions have important role in learning process. Misconceptions and students' pre existing knowledge may prevent the conceptual understanding of the science. Teachers can determine students' misconceptions by different learning material such as misconception tests, open-ended questions and interviews. If the teacher determines the students' misconceptions before instruction, he or she decides on the concepts to be emphasized, determine the sequence of the instruction.

6. Teacher education should place an emphasis on teaching strategies based on conceptual change approach. Teacher should be encouraged to use conceptual change text in instrucitonal activities.

7. Teachers should be informed about the limitations of analogy, and they should be preventing them from occurring.

8. Teacher must pay attention the concepts, figures and examples and language that used in the texts and textbooks.

9. Teachers should be sensitive to the students' attitudes toward science. They must realize that attitudes affect the students' achievement and try to make students have positive attitudes toward science as a school subject.

10. Science process skill is a strong predictor of science achievement. Teacher should adjust their teaching strategies to develop students' science process skills.

6.3 Recommendations

Based on the results of the study the followings recommendations can be offered:

1. Similar studies may be conducted for different grade level students or different courses.

2. Further research can be conducted in university.

3. Further research can be conducted to trainee teachers.

4. In this study, sample is small. Sample size should be increased for further research in order to obtain more accurate result.

5. For further research, conceptual change text instruction may be compared with other instructional strategies such as computer assisted instruction, demonstration.

6. Different instruments such as worksheets including conceptual problems, demostrations, pictorial presentation and conceptual assignments to enrich the instruction of chemical bond topic.

7. The conceptual change oriented instruction accompanied with analogies can be used to teach different science topics.

8. Further research can be conducted to evaluate students' motivation, interest in analogies, reasoning abilities, and learning styles effect on students' performance in science topics.

9. Further studies can be conducted using the conceptual change approach with different teaching strategies such as hand-on activities and problem-

based learning in remediation of students' misconceptions and increasing students' understanding in chemical bonds.

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APPANDIX A

INSTRUCTIONAL OBJECTIVES

To describe atoms.

To describe molecules.

To distinguish between atom and molecule.

To describe ions.

To describe anyons and cations.

To distinguish between anyon and cation.

To distinguish the kind of ions according to number of electrons.

To explain how chemical bonding occurs.

To describe types of chemical bonds

To describe ionic bond and to explain properties of ionic bond .

To describe covalent bond and to properties of covalent bond.

To distinguish the covalent bonding and ionic bonding.

To give examples for ionic and covalent bonds.

To determine the kind of chemical bond according to atomic number of elements.

To explain metals and nometals role in ionic and covalent bond.

To explain why the noble gases do not make chemical bonds.

To explain the role of proton, electron and neutron in chemical bond.

To distinguish the affects of elements location in periodic table to chemical bond.

To distinguish the ionic and covalent bond according to models of compounds.

To give examples for ionic and covalent compounds.

To infer the relation between molecules and covalent bonds.

To estimate physical properties of compounds according to the type of bonds they have.

To distinguish characteristics of metal, nonmetal and noble gas.

To estimate type of bonds that a substance has.

APPENDIX B

KİMYASAL BAĞLAR KAVRAM TESTİ

YÖNERGE: Bu test, sizin Kimyasal bağlar konusundaki kavramları ne derecede öğrendiğinizi değerlendirmek için hazırlanmıştır. Testte toplam yirmi beş (25) tane çoktan seçmeli soru vardır. Her bir sorunun dört tane seçeneği vardır, ancak sadece bir tane doğru cevabı vardır. Soruları cevaplarken dikkatli olmanız ve cevapları, cevap anahtarına işaretlemeniz gerekmektedir.

1. Ezgi kimyasal bağlar ile ilgili aşağıdaki bilgileri veriyor.

I.Bir bileşikteki atomları bir arada tutan kuvvetlerdir.

II.İyonik bağ elektron alışverişi ile oluşur.

III. Kovalent bağ elektron ortaklaşa kullanımı sonucu oluşur.

Ezgi'nin verdiği bilgilerden hangileri doğrudur?

A) Yalnız I B) I ve II C) I ve III D) I , II ve III

2. **I**. N (azot)

II. O (oksijen)

III. Al (aliminyum)

Yukarıdaki elementlerden hangileri hem iyonik, hem de kovalent bağ yapabilir?

A) Yalnız I B) Yalnız II C) I ve II D) I , II ve III

3. Aşağıdakilerin hangisinde molekülün karşısındaki kimyasal bağın türü yanlış verilmiştir?

($_{7}N$, $_{8}O$, $_{11}Na$, $_{17}Cl$, $_{19}K$, $_{9}F$)

Molekül	Bağın türü
A) N_3	üçlü kovalent bağ
B) O_2	ikili kovalent bağ
C) NaCl	tekli kovalent bağ
D) K F	tekli iyonik bağ

4.

element	K	L	M	N
Atom numarası	3	8	10	17

Yukarıda bazı elementlerin atom numaraları tablo halinde verilmiştir. Buna göre kovalent bağlı bileşik oluşturmak isteyen bir öğrenci tablodaki elementlerden hangilerini kullanmalıdır?

A)K-L B)L-N C)M-N D)K-M

5. Kimyasal bağlar için;

I. Her atom kimyasal bağ yapabilir.

II. Kovalent bağda elektron ortaklaşa kullanılır.

III. İyonik bağda proton alış verişi olur.

Yargılarından hangileri doğrudur?

A) Yalnız I B) Yalnız II C) II ve III D) I , II ve III

6.

Ayça Esra Ayça Kaya Esra Mete

Yukarıda elementleri temsil eden bazı öğrencilerin birbirlerine olan bağ durumlarının resimleri gösterilmiştir.

Buna göre;

a. Ayça metal ise Kaya soygazdır.

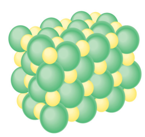
b. Esra metal, Ayça ametal ise aralarında oluşan bağ iyoniktir.

c. Esra ve Mete ametal ise oluşan bağ kovalenttir.

Yargılarından hangisi ya da hangilerinin doğruluğu kesin değildir?

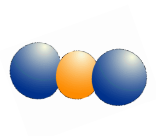
A) Yalnız I B) Yalnız II C) I ve II D) II ve III

7.



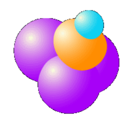
KCl

I



CO_2

II



HNO_3

III

Şekilde modeli verilen bileşiklerden hangileri iyonik bağlarla oluşmuştur?

A) Yalnız I B) I ve II C) II ve III D) I , II ve III

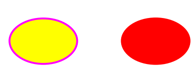
8.

Element	I. katman e^- sayısı	II. katman e^- sayısı	III. katman e^- sayısı
X	1	_	_
Y	2	7	_
Z	2	8	3
T	2	2	_

Şekilde modeli verilen bileşiklerden hangileri arasında kimyasal bağ oluşmaz?

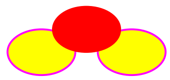
A)X-Z B)Y-T C)X-Y D)Z-T

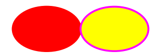
9.

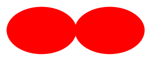


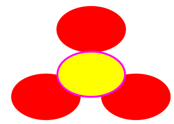
X Y

Şekilleri gösterilen ametal X ve metal Y element atomlarından oluşan aşağıdaki moleküllerin hangisindeki bağ diğerlerinden farklıdır?

A) 

B) 

C) 

D) 

10.

Atom	1.katmandaki elektron sayısı	2.katmandaki elektron sayısı	3.katmandaki elektron sayısı
X	2	8	6
Y	2	8	7
Z	2	8	3

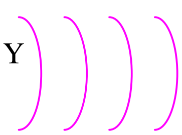
X, Y ve Z atomlarıyla ilgili yukarıdaki tabloda bazı bilgiler verilmiştir.
Buna göre X, Y ve Z atomlarından hangileri kovalent bağ oluşturabilir?

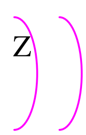
A)X veY B)X ve Z C)Z ve Y D) X, Y ve Z

11. Bir atomun en dış katmanında bulunan elektronlarına değerlik elektronları denir. Değerlik elektron sayısı 1,2 ya da 3 olan atomlar genellikle metal; 5,6 ya da 7 olan atomlar genellikle ametaldir.

Buna göre aşağıda elektron dizilimleri verilen atomlardan hangileri arasında iyonik bağ oluşmaz?

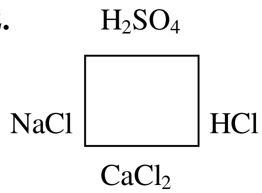
I. X 
2 8 2

II. Y 
2 8 8 1

III. Z 
2 6

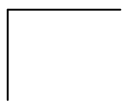
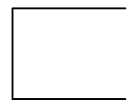
A) I ve III B) I ve II C) II ve III D) I , II ve III

12.



Yanda verilen karenin her bir kenarı bir bileşiği ifade emektedir.

Bu bileşiklerden kovalent bağlı olanlar çıkarılırsa aşağıdaki şekillerden hangisi elde edilir?

A)  B)  C)  D) 

13. Kimyasal bağ oluşurken aşağıda verilen niceliklerden hangisinde veya hangilerinde değişme olur?

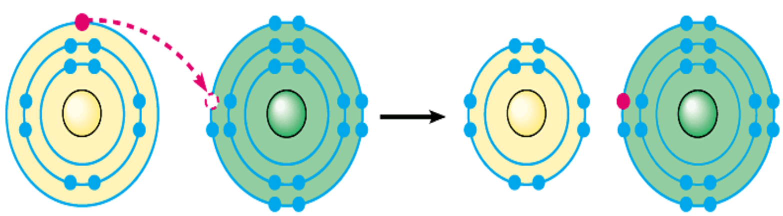
I. Elektron sayısı

II. Proton sayısı

III. Nötron sayısı

A) I ve II B) Yalnız I C) Yalnız II D) I , II ve III

14.

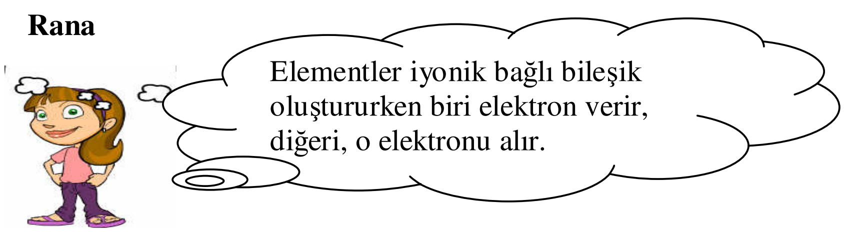


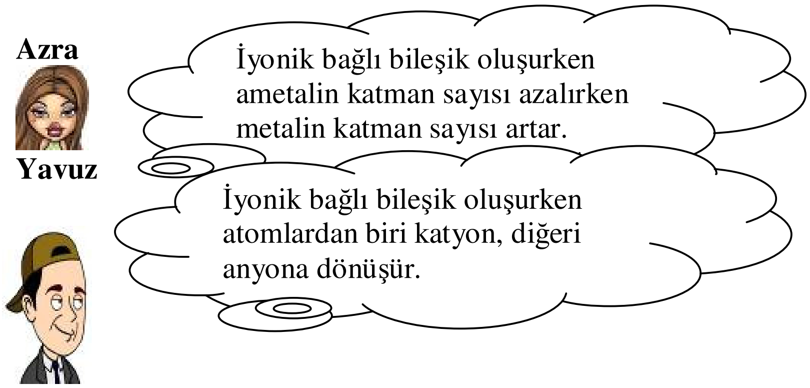
.

Na **Cl** **NaCl**

Fen öğretmeni, iyonik bağların oluşumu için NaCl (sofra tuzu) oluşumunu örnek veriyor. Bu şekille ilgili öğrenci yorumları aşağıdaki gibidir.

Rana





Buna göre hangi öğrencilerin yorumları doğrudur?

A) Rana B) Rana ve Yavuz

C) Azra ve Yavuz D) Rana ve Azra

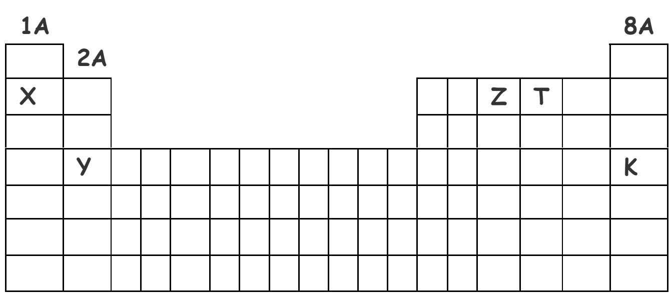
15. ● H_2O ● O_2 ● CO_2 ● NaCl

● H_2S ● HF ● CH_4

Yukarıda günlük hayatta karşılaştığımız bazı moleküller verilmiştir. Buna göre verilen moleküllerden kaç tanesi iyonik bağlıdır?

A)1 B)2 C)3 D)4

16.



Periyodik tabloda yerleri verilen elementlerin oluşturacakları kimyasal bağlar ile ilgili aşağıdakilerden hangisinde doğru sınıflandırma yapılmıştır?

	İyonik bağ	kovalent bağ
A)	X ile Y	Z ile T
B)	X ile T	Z ile T
C)	X ile T	Z ile K
D)	Y ile Z	T ile K

17.

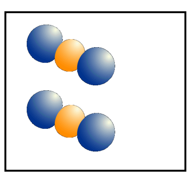
Element	**Atom numarası**
X	12
Y	7
Z	3
T	16

Yukarıdaki tabloda atom numarası verilen X,Y, Z ve T atomları arasında oluşacak bileşiklerden hangisinin bağ türü diğrlerinden farklıdır?

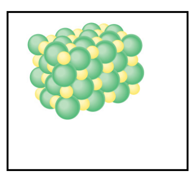
A) X ile Y B) Z ile T

C) X ile T D) Y ile T

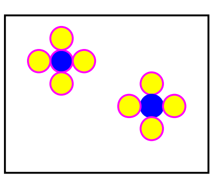
18.



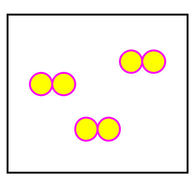
I
(CO_2)



II
NaCl



III
(SO_4)



IV
(O_2)

Şekilde tanecik yapıları verilen maddelerden iyonik ve kovalent bağlı olanlar hangileridir?

	İyonik bağ	kovalent bağ
A)	I ile III	II ile IV
B)	II ile IV	I ile III
C)	II	I, III ve IV
D)	III ile IV	I ile II

19. ● **A** atomunun son katmanında 3 elektron bulunur.

● **B** atomunun son katmanında 7 elektron bulunur.

● **C** atomunun son katmanında 6 elektron bulunur.

Yukarıda A,B ve C atomlarının son katmanlarında bulunan elektron sayıları verilmiştir.

Buna göre A,B,C atomları arasında oluşan bileşiklerin basit formülleri ve bağ çeşidi ile ilgili olarak aşağıdaki tablolardan hangisi doğrudur?

A)

Bileşik	İyonik bağ	Kovalent bağ
AB_3	√	
B_2C		√

B)

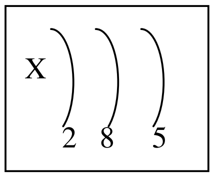
bileşik	İyonik bağ	Kovalent bağ
A_2C_3		√
B_2C	√	

C)

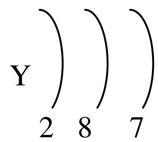
Bileşik	İyonik bağ	Kovalent bağ
AB_3		√
B_2C	√	

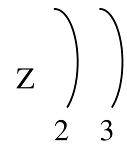
D)

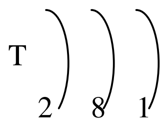
bileşik	İyonik bağ	Kovalent bağ
A_2C_3	√	
B_2C		√

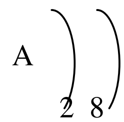
20 . 

Yandaki şekilde nötr haldeki X atomunun elektron dağılımı verilmiştir. Buna göre X atomu, aşağıda verilen atomların hangisi ile kovalent bağ oluşturur?

A) 

B) 

C) 

D) 

21. Öğrenciler HCl, NH_3 bileşiklerinin atomlarının birbirine yakınlığını inceler ve bazı atomların birbirine çok yakın olduklarını, aralarında kuvvetli bir çekim kuvveti olduğunu, bazılarının ise çok yakın olmadıklarını gözlemler.

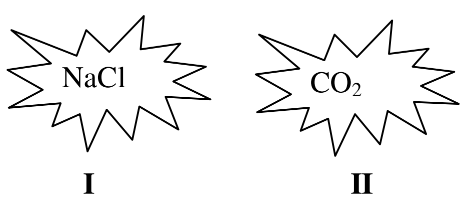
Buna göre aşağıda verilen bilgilerden hangisi veya hangileri yanlıştır?

I. Zıt yüklü iyonlar biribirine en yakındır.

II. Özdeş yüklü iyonlar en yakındır.

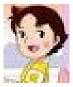
III. Zıt yüklü iyonlar arasında kimyasal bağ oluşumu vardır.

A) Yalnız I B) I ve III C) Yalnız II D) II ve III

22. 

Yukarıdaki bilşeşiklerle ilgili olarak aşağıdaki öğrencilerden hangisi ya da hangileri doğru bilgi vermiştir?

Bahar



I. de molekül oluşmaz

Ali

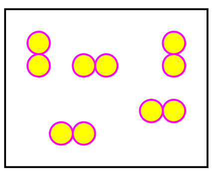
II. de molekül oluşur.

Ekin

I'de iyonik bağ, II'de kovalent bağ vardır.

A) Bahar B) Ekin

C) Bahar ve Ali D) Bahar, Ali ve Ekin

23. 

Öğrenciler iyot atomlarına ait yandaki modeli inceliyor. Buna göre aşağıda verilen bilgilerden hangisi ya da hagileri yanlıştır?

I. Atomlar arasında iyonik bağ vardır.

II. Elektronların ortaklaşa kullanımı oktet kuralına uyar.

III. Cl_2 molekülünün bağ oluşumuna uymaz.

IV.

A) Yalnız I B) I ve III C) Yalnız III D) I ve II

24. Aşağıdakilerden hangisi iyonik bağlı bileşiklerin tanecikleridir?

A) Atomlar B) Moleküller C) İyonlar D) Katyonlar

25. Aşağıda verilen maddelerden hangisinde kimyasal bağ yoktur?

A) Bronz B) Su C) Şeker D)Tuz

APPENDIX C

KİMYASAL BAĞLAR ÖN TEST SORULARI

YÖNERGE: Bu ön test sizin Kimyasal bağlar konusundaki kavramları 7. sınıfta ne derecede öğrendiğinizi değerlendirmek için hazırlanmıştır. Ön testte toplam yirmi beş (25) tane çoktan seçmeli soru vardır. Her bir sorunun dört tane seçeneği vardır, ancak sadece bir tane doğru cevabı vardır. Soruları cevaplarken dikkatli olmanız ve cevapları cevap anahtarına işaretlemeniz gerekmektedir.

1.Aşağıdakilerden hangisi kovalent bağlı bileşiklerin tanecikleridir?

A) Atomlar B) Moleküller C) İyonlar D) Katyonlar

2.Suyun kaynaması olayı sırasında aşağıdaki olaylardan hangisi gerçekleşir?

A) Taneciklerin kütlesi artar.

B) Moleküller arası bağ zayıflar tanecikler arası uzaklık artar

C) Moleküller arası bağ zayıflar, tanecikler arası uzaklık azalır.

D) Tanecikler küçülür.

3. Aşağıdakilerden hangisi yanlıştır?

A) Amatallerin elektron ilgisi metallerden çoktur.

B) Bir atom başka bir atom ile ancak kovalent bağ yapar.

C) Hidrojen (1A) ile Klor (7A) arasında kovalent bağ vardır.

D) Elektron alışverişi ile iyonik bağ oluşur.

4. Klor elementi elektron……..yatkındır. Magnezyum elementi ile ……… bağ yapar.

Yukarıdaki cümlede boş bırakılan yerlere hangi kelimelerin gelmesi uygun olur?

A) Almaya-iyonik B) Vermeye-iyonik

C) Almaya-kovalent D) Vermeye-kovalent

5. Atom numarası 11 olan Sodyum (Na) elementinin nötr halde kaç temel enerji düzeyi (yörüngesi) Vardır?

A) 2 B) 3 C) 1 D) 4

6. Atom numarası 11 olan sodyum elementinin nötr halde son yörüngesinde kaç elektronu vardır?

A) 1 B)2 C)3 D)4

7. Atom numarası 12 olan Magnezyum elementinin kararlı hale gelebilmesi için iyon yükü ne olmalıdır?

A) +1 B)-1 C)+2 D)-2

8. Eksi yüklü atoma ne ad verilir?

A) Molekül B) Katyon C) Atom D) Anyon

9. Al $_{13}$ atomu ie aşağıdakilerden hangisi iyonik bağ yapar?

A) Mg_{12} B) K $_{19}$ C) Cl_{17} D) Ca_{20}

10. F_9 atomu ile aşağıdakilerden hangisi kimyasal bağ yapmaz?

A) K_{19} B) He_2 C) H_1 D) F_9

11. Aşağıda verilen hangi gruplar arasında kimyasal bağ oluşmaz?

A) Metal-ametal B) Aynı ametal atomları

C) Farklı ametal atomları D) Metal-metal

12.Mg (2A) grubu elementi ile hangi element arasında kovalent bağ oluşur?

A) Ametal arasında B) Metal arasında

C) Soygaz arasında D) Hiçbiri

13. Aşağıdakilerden hangisi iyonik bileşiklerin tanecikleridr?

A) Atomlar B) Katyonlar C) Moleküller D) İyonlar

14. Aşağıdakilerden hangisi en kararlı atomlara sahiptir?

A) Soygazlar B) Ametaller C) Metaller D) Yarımetaller

15. Periyodik cetvelde elemetlerin atomlarının çapı nasıl değişir?

Yukarıdan aşağı	sağdan sola
A) artar	artar
B) artar	azalır
C) azalır	artar
D) azalır	azalır

16. Elementler birleşerek bileşik oluşturduklarında elementin atomunda hangi değişiklik kesinlikle olur?

A) Proton sayısı değişir.

B) Nötron sayısı değişir.

C) Değerlik elektron sayılarında değişiklik olur.

D) Kabuk sayılarında değişiklik olur.

17. İki atomun elektronlarını ortak kullanması sonucu oluşan bağa ne ad verilir?

A) Metalik bağ B) İyonik bağ

C) Hidrojen bağı D) Kovalent bağ

18. Kalsiyum (Ca, 2A grubu) elementi ile Iyot (I, 7A grubu) elementi bileşik oluştururken elementlerin atomları arasında nasıl bir ilşki olur?

A) Arasında elektron aktarımı olur. B) Birbirine yapışır.

C) Arasında elektron ortaklaşması olur. D) Karışım oluştururlar.

19. Aşağıda verilen maddelerden hangisinde bağ yoktur?

A) Bronz B)Su C)Şeker D)Tuz

20. Kimyasal bağlar için,

I. Her atom kimyasal bağ yapabilir.

II.Kovalent bağda elektron ortak kullanılır.

III.İyonik bağda proton alışverişi olur.

Yargılarından hangileri doğrudur?

A)Yalnız I B) Yalnız II C)II, III D)I, II, III

21. Atomlar arasında elektron alışverişi ile oluşan bağa ……… bağ denir. Molekül yapılı bileşiklerde atomlar arasında …… bağ vardır.

Yukarıdaki ifadelerde boş bırakılan yerlere sırası ile ne gelmelidir?

A) İyonik-kovalent B) Molekül-iyonik

C) İyonik-molekül D) Kovalent-iyonik

22. Aşağıdaki atom çiftlerinden hangisinde atomlar elektronlarını ortaklaşa kullanarak bileşik oluştururlar?

A) S_{16}-O_8 B) Na_{11}- Li_3

C) Ca_{20}- F_9 D) Be_4- Al_{13}

23.

element	Proton sayısı	Nötron sayısı
X	12	12
Y	11	12
Z	9	10
T	8	8

Yandaki tabloya göre hangi elementler arasında iyonik bağ oluşur?

A)X-T B)X-Y C)Z-T D)Z-Z

24. İyonik bağlar için aşağıdaki yargılardan hangisi yanlıştır?
A) Elektron alışverişi sonucu oluşur.
B) Bileşiklerinin sulu çözeltisi elekttrik akımını iletir.
C) Katyon ve anyonlar olşur.
D) Oluşturduğu bileşikler moleküler yapıdadır.

25. X metal, Y ve Z ametal olduğuna göre X, Y ve Z'nin oluşturduğu bileşiklerdeki bağ cinsleri aşağıdakilerden hangisinde veya hangilerinde doğru olarak verilmiştir?
I. X-Y arasında iyonik bağ
II. X-Z arasında kovalent bağ
III. Y-Z arasında kovalent bağ

A) Yalnız I B) Yalnız II C) I ve III D) II ve III

APPENDIX D

FEN VE TEKNOLOJİ DERSİ TUTUM ÖLÇEĞİ

AÇIKLAMA: Bu ölçek, Fen ve teknoloji dersine ilişkin tutum cümleleri ile her cümlenin karşısında Tamamen Katılıyorum, Katılıyorum, Kararsızım, Katılmıyorum ve Hiç Katılmıyorum olmak üzere beş seçenek verilmiştir. Her cümleyi dikkatle okuduktan sonra kendinize uygun seçeneği işaretleyiniz.

	Tamamen Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
1.Fen ve Teknoloji çok sevdiğim bir alandır.	☐	☐	☐	☐	☐
2. Fen ve Teknoloji ile ilgili kitaplar okumayı severim.	☐	☐	☐	☐	☐
3. Fen ve Teknolojinin günlük yaşamda pek yeri yoktur.	☐	☐	☐	☐	☐
4. Fen ve Teknoloji ile ilgili ders problemlerini çözmekten hoşlanırım.	☐	☐	☐	☐	☐
5. Fen ve Teknoloji konuları ile ilgili daha çok şey öğrenmek isterim.	☐	☐	☐	☐	☐
6. Fen ve Teknoloji dersine girerken sıkıntı duyarım.	☐	☐	☐	☐	☐
7. Fen ve Teknoloji dersine zevkle girerim	☐	☐	☐	☐	☐
8. Fen ve Teknoloji dersine ayrılan sürenin daha çok olmasını isterim.	☐	☐	☐	☐	☐
9. Fen ve Teknoloji dersine çalışırken sıkılırım	☐	☐	☐	☐	☐
10. Fen ve Teknoloji konularını ile ilgiligünlük olaylar hakkında daha çok bilgi edinmek isterim.	☐	☐	☐	☐	☐
11.Düşünce sistemimizi geliştirmede Fen ve Teknoloji öğrenimi önemlidir.	☐	☐	☐	☐	☐
12. Fen ve Teknoloji doğal olayları anlamamızda önemlidir.	☐	☐	☐	☐	☐
13.Dersler içinde Fen ve Teknoloji sevimsiz gelir.	☐	☐	☐	☐	☐
14. Fen ve Teknoloji konuları ile ilgili tartışmaya ktılmak bana cazip gelmez.	☐	☐	☐	☐	☐
15. Çalışma zamanımın önemli bir kısmını Fen ve teknoloji dersine ayırmak isterim.	☐	☐	☐	☐	☐

APPENDIX E

BİLİMSEL İŞLEM BECERİ TESTİ

AÇIKLAMA: Bu test, özellikle Fen ve Matematik derslerinizde ve ilerde üniversite sınavlarında karşınıza çakabilecek karmaşık gibi görünen problemleri analiz edebilme kabiliyetinizi ortaya çıkarabilmesi açısından çok faydalıdır. Bu test içinde, problemdeki değişkenleri tanımlayabilme, hipotez kurma ve tanımlama, işlemsel açıklamalar getirebilme, problemin çözümü için gerekli incelemelerin tasarlanmasa, grafik çizme ve verileri yorumlayabilme kabiliyetlerini ölçebilen sorular bulunmaktadır. Her soruyu okuduktan sonra kendinizce uygun seçeneği yalnızca cevap kağıdına işaretleyiniz. Bu testin orijinali James R. Okey, Kevin C. Wise ve Joseph C. Burns tarafından geliştirilmiştir. Türkçeye çevrisi ve uyarlaması ise Prof. Dr. Ylker Özkan, Prof. Dr. Petek Aşkar ve Prof. Dr. Ömer Geban tarafından yapılmıştır.

1. Bir basketbol antrenörü, oyuncuların güçsüz olmasından dolayı maçları kaybettiklerini düşünmektedir. Güçlerini etkileyen faktörleri araştırmaya karar verir. Antrenör, oyuncuların gücünü etkileyip etkilemediğini ölçmek için aşağıdaki değişkenlerden hangisini incelemelidir?

a. Her oyuncunun almış olduğu günlük vitamin miktarını.
b. Günlük ağırlık kaldırma çalışmalarının miktarını.
c. Günlük antrenman süresini.
d. Yukarıdakilerin hepsini

2. Arabaların verimliliğini inceleyen bir araştırma yapılmaktadır. Sınanan hipotez, benzine katılan bir katkı maddesinin arabaların verimliliğini artırdığı yolundadır. Aynı tip beş arabaya aynı miktarda benzin fakat, farklı miktarlarda katkı maddesi konur. Arabalar benzinleri bitinceye kadar aynı yol üzerinde giderler. Daha sonra her arabanın aldığı mesafe kaydedilir. Bu çalışmada arabaların verimliliği nasıl ölçülür?

a. Arabaların benzinleri bitinceye kadar geçen süre ile.

b. Her arabanın gittiği mesafe ile.

c. Kullanılan benzin miktarı ile.

d. Kullanılan katkı maddesinin miktarı ile.

3. Bir araba üreticisi daha ekonomik arabalar yapmak istemektedir. Araştırmacılar arabanın litre başına alabileceği mesafeyi etkileyebilecek değişkenleri araştırmaktadırlar. Aşağıdaki değişkenlerden hangisi arabanın litre başına alabileceği mesafeyi etkileyebilir?

a. Arabanın ağırlığı.

b. Motorun hacmi.

c. Arabanın rengi

d. a ve b.

4. Ali Bey, evini ısıtmak için komşularından daha çok para ödenmesinin sebeplerini merak etmektedir. Isınma giderlerini etkileyen faktörleri araştırmak için bir hipotez kurar. Aşağıdakilerden hangisi bu araştırmada sınanmaya uygun bir hipotez değildir?

a. Evin çevresindeki ağaç sayısı ne kadar az ise ısınma gideri o kadar fazladır.

b. Evde ne kadar çok pencere ve kapı varsa, ısınma gideri de o kadar fazla olur.

c. Büyük evlerin ısınma giderleri fazladır.

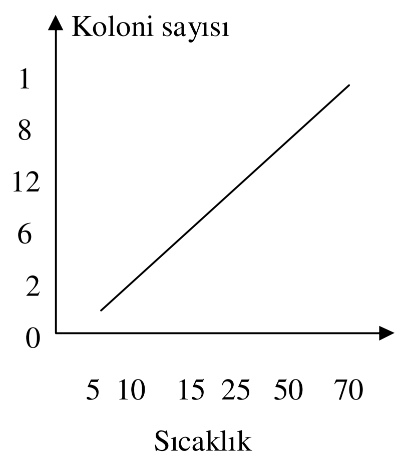
d. Isınma giderleri arttıkça ailenin daha ucuza ısınma yolları araması gerekir.

5. Fen sınıfından bir öğrenci sıcaklığın bakterilerin gelişmesi üzerindeki etkilerini araştırmaktadır. Yaptığı deney sonucunda, öğrenci aşağıdaki verileri elde etmiştir:

Deney odasının sıcaklığı 5	Bakteri kolonilerinin sayısı 0
10	2
15	6
25	12
50	8
70	1

Aşağıdaki grafiklerden hangisi bu verileri doğru olarak göstermektedir?

a)



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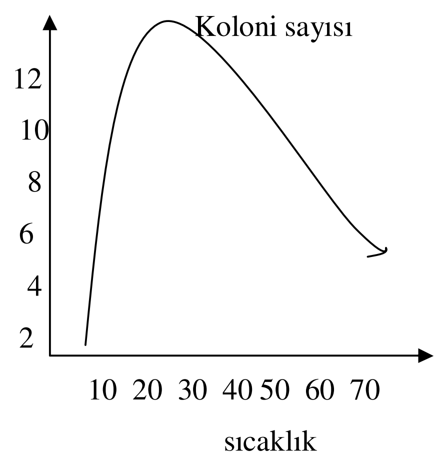
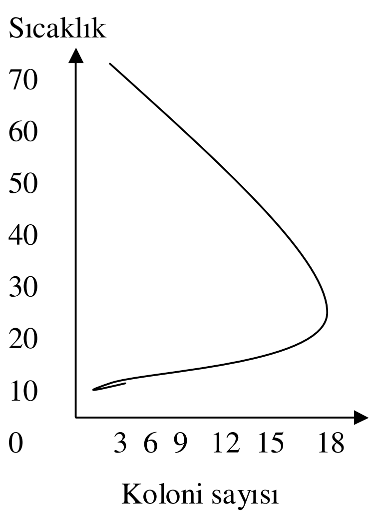
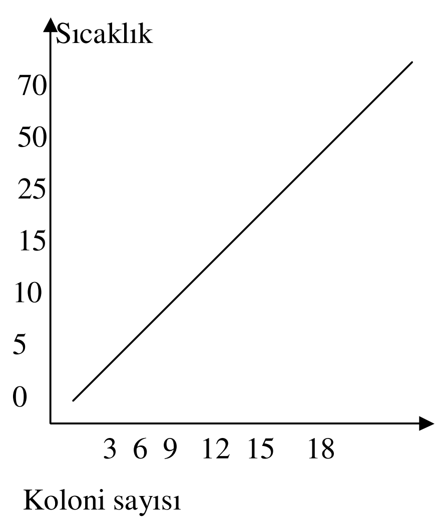


c)



d)



6. Bir polis şefi, arabaların hızının azaltılması ile uğraşmaktadır. Arabaların hızını etkileyebilecek bazı faktörler olduğunu düşünmektedir. Sürücülerin ne kadar hızlı araba kullandıklarını aşağıdaki hipotezlerin hangisiyle sınayabilir?

a. Daha genç sürücülerin daha hızlı araba kullanma olasılığı yüksektir.

b. Kaza yapan arabalar ne kadar büyükse, içindeki insanların yaralanma olasılığı o kadar azdır.

c. Yollarda ne kadar çok polis ekibi olursa, kaza sayısı o kadar az olur.

d. Arabalar eskidikçe kaza yapma olasılıkları artar.

7. Bir fen sınıfında, tekerlek yüzeyi genişliğinin tekerleğin daha kolay yuvarlanması üzerine etkisi araştırılmaktadır. Bir oyuncak arabaya geniş yüzeyli tekerlekler takılır, önce bir rampadan (eğik düzlem) aşağı bırakılır daha sonra düz bir zemin üzerinde gitmesi sağlanır. Deney, aynı arabaya daha dar yüzeyli tekerlekler takılarak tekrarlanır. Hangi tip tekerleğin daha kolay yuvarlandığı nasıl ölçülür?

a. Her deneyde arabanın gittiği toplam mesafe ölçülür.

b. Rampanın (eğik düzlem) eğim açısı ölçülür.

c. Her iki deneyde kullanılan tekerlek tiplerinin yüzey genişlikleri ölçülür.

d. Her iki deneyin sonunda arabanın ağırlıkları ölçülür.

8. Bir çiftçi daha çok mısır üretebilmenin yollarını aramaktadır. Mısırların miktarını etkileyen faktörleri araştırmayı tasarlar. Bu amaçla aşağıdaki hipotezlerden hangisini sınayabilir?

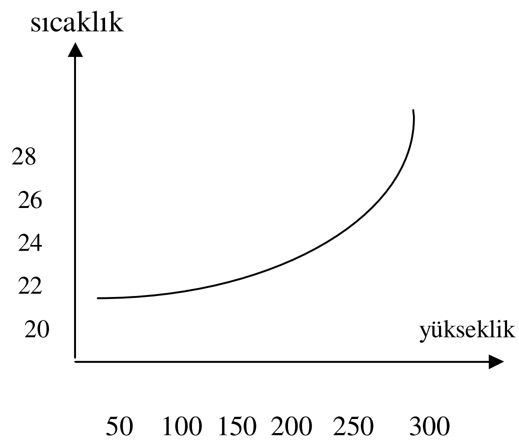
a. Tarlaya ne kadar çok gübre atılırsa, o kadar çok mısır elde edilir.

b. Ne kadar çok mısır elde edilirse, kar o kadar fazla olur

c. Yağmur ne kadar çok yağarsa , gübrenin etkisi o kadar çok olur.

d. Mısır üretimi arttıkça, üretim maliyeti de artar

9 Bir odanın tabandan itibaren değişik yüzeylerdeki sıcaklıklarla ilgili bir çalışma yapılmış ve elde edilen veriler aşağıdaki grafikte gösterilmiştir. Değişkenler arasındaki ilişki nedir?



a. Yükseklik arttıkça sıcaklık azalır.

b. Yükseklik arttıkça sıcaklık artar

c. Sıcaklık arttıkça yükseklik azalır.

d. Yükseklik ile sıcaklık artışı arasında bir ilişki yoktur.

10. Ahmet, basketbol topunun içindeki hava arttıkça, topun daha yükseğe sıçrayacağını düşünmektedir. Bu hipotezi araştırmak için, birkaç basketbol topu alır ve içlerine farklı miktarda hava pompalar. Ahmet hipotezini nasıl sınamalıdır?

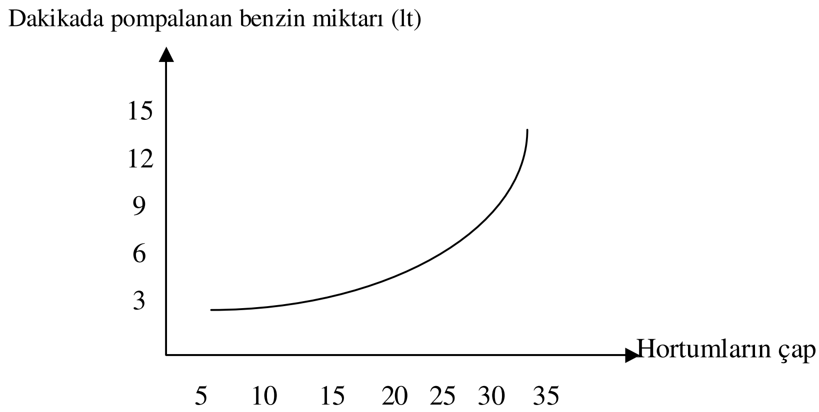
a. Topları ayni yükseklikten fakat değişik hızlarla yere vurur.

b. İçlerinde farklı miktarlarda hava olan topları, aynı yükseklikten yere bırakır.

c. İçlerinde aynı miktarlarda hava olan topları, zeminle farklı açılardan yere vurur

d. İçlerinde aynı miktarlarda hava olan topları, farklı yüksekliklerden yere bırakır.

11. Bir tankerden benzin almak için farklı genişlikte 5 hortum kullanılmaktadır. Her hortum için aynı pompa kullanılır. Yapılan çalışma sonunda elde edilen bulgular aşağıdaki grafikte gösterilmiştir.



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi açıklamaktadır?

a. Hortumun çapı genişledikçe dakikada pompalanan benzin miktarı da artar.

b. Dakikada pompalanan benzin miktarı arttıkça, daha fazla zaman gerekir.

c. Hortumun çapı küçüldükçe dakikada pompalanan benzin miktarı da artar.

d. Pompalanan benzin miktarı azaldıkça, hortumun çapı genişler

Önce aşağıdaki açıklamayı okuyunuz ve daha sonra 12, 13, 14 ve 15 inci soruları açıklama kısmından sonra verilen paragraf okuyarak cevaplayınız.

Açıklama: Bir araştırmada, bağımlı değişken birtakım faktörlere bağımlı olarak gelişim gösteren değişkendir. Bağımsız değişkenler ise bağımlı değişkene etki eden faktörlerdir. Örneğin, araştırmanın amacına göre kimya başarısı bağımlı bir değişken olarak alınabilir ve ona etki edebilecek faktör veya faktörler de bağımsız değişkenler olurlar.

Ayşe, güneşin karaları ve denizleri aynı derecede ısıtıp ısıtmadığını merak etmektedir. Bir araştırma yapmaya karar verir ve aynı büyüklükte iki kova alır.Bunlardan birini toprakla, diğerini de su ile doldurur ve aynı miktarda güneş ısısı alacak şekilde bir yere koyar. 8.00 - 18.00 saatleri arasında, her saat başı sıcaklıklarını ölçer.

12. Araştırmada aşağıdaki hipotezlerden hangisi sınanmıştır?

a. Toprak ve su ne kadar çok güneş ışığı alırlarsa, o kadar ısınırlar.

b. Toprak ve su güneş altında ne kadar fazla kalırlarsa, o kadar çok ısınırlar.

c. Güneş farklı maddeleri farklı derecelerde ısıtır.

d. Günün farklı saatlerinde güneşin ısısı da farklı olur.

13. Araştırmada aşağıdaki değişkenlerden hangisi kontrol edilmiştir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin türü.

d. Her bir kovanın güneş altında kalma süresi.

14. Araştırmada bağımlı değişken hangisidir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı

c. Kovalara koyulan maddenin türü.

d. Her bir kovanın güneş altında kalma süresi.

15. Araştırmada bağımsız değişken hangisidir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı

c. Kovalara koyulan maddenin türü.

d. Her bir kovanın güneş altında kalma süresi

16. Can, yedi ayrı bahçedeki çimenleri biçmektedir. Çim biçme makinesiyle her hafta bir bahçedeki çimenleri biçer. Çimenlerin boyu bahçelere göre farklı olup bazılarında uzun bazılarında kısadır. Çimenlerin boyları ile ilgili hipotezler kurmaya başlar. Aşağıdakilerden hangisi sınanmaya uygun bir hipotezdir?

a. Hava sıcakken çim biçmek zordur.

b. Bahçeye atılan gübrenin miktarı önemlidir.

c. Daha çok sulanan bahçedeki çimenler daha uzun olur.

d. Bahçe ne kadar engebeliyse çimenleri kesmek de o kadar zor olur

17, 18, 19 ve 20 nci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Murat, suyun sıcaklığının, su içinde çözünebilecek şeker miktarını etkileyip etkilemediğini araştırmak ister. Birbirinin aynı dört bardağın her birine 50'şer mililitre su koyar. Bardaklardan birisine 0 ^{0}C de, diğerine de sırayla 50 ^{0}C, 75 ^{0}C ve 95 ^{0}C sıcaklıkta su koyar. Daha sonra her bir bardağa çözünebileceği kadar Şeker koyar ve karıştırır.

17. Bu araştırmada sınanan hipotez hangisidir?
a. Şeker ne kadar çok suda karıştırılırsa o kadar çok çözünür.
b. Ne kadar çok şeker çözünürse, su o kadar tatlı olur.
c. Sıcaklık ne kadar yüksek olursa, çözünen şekerin miktarı o kadar fazla olur.
d. Kullanılan suyun miktarı arttıkça sıcaklığı da artar.

18. Bu araştırmada kontrol edilebilen değişken hangisidir?
a. Her bardakta çözünen şeker miktarı.
b. Her bardağa konulan su miktarı.
c. Bardakların sayısı.
d. Suyun sıcaklığı.

19. Araştımanın bağımlı değişkeni hangisidir?
a. Her bardakta çözünen şeker miktarı.
b. Her bardağa konulan su miktarı.
c. Bardakların sayısı.
d. Suyun sıcaklığı.

20. Araştırmadaki bağımsız değişken hangisidir?
a. Her bardakta çözünen şeker miktarı.
b. Her bardağa konulan su miktarı.
c. Bardakların sayısı.
d. Suyun sıcaklığı.

21. Bir bahçıvan domates üretimini artırmak istemektedir. Değişik birkaç alana domates tohumu eker. Hipotezi, tohumlar ne kadar çok sulanırsa, o kadar çabuk filizleneceğidir. Bu hipotezi nasıl sınar?

a. Farklı miktarlarda sulanan tohumların kaç günde filizleneceğine bakar.

b. Her sulamadan bir gün sonra domates bitkisinin boyunu ölçer.

c. Farklı alanlardaki bitkilere verilen su miktarını ölçer.

d. Her alana ektiği tohum sayısına bakar.

22. Bir bahçıvan tarlasındaki kabaklarda yaprak bitleri görür. Bu bitleri yok etmek gereklidir. Kardeşi "Kling" adlı tozun en iyi böcek ilacı olduğunu söyler. Tarım uzmanları ise "Acar" adlı spreyin daha etkili olduğunu söylemektedir. Bahçıvan altı tane kabak bitkisi seçer. Üç tanesini tozla, üç tanesini de spreyle ilaçlar. Bir hafta sonra her bitkinin üzerinde kalan canlı bitleri sayar. Bu çalışmada böcek ilaçlarının etkinliği nasıl ölçülür?

a. Kullanılan toz ya da spreyin miktarı ölçülür.

b. Toz ya da spreyle ilaçlandıktan sonra bitkilerin durumları tespit edilir.

c. Her fidede oluşan kabağın ağırlığı ölçülür.

d. Bitkilerin üzerinde kalan bitler sayılır.

23. Ebru, bir alevin belli bir zaman süresi içinde meydana getireceği ısı enerjisi miktarını ölçmek ister. Bir kabın içine bir litre soğuk su koyar ve 10 dakika süreyle ısıtır. Ebru, alevin meydana getirdiği ısı enerjisini nasıl ölçer?

a. 10 dakika sonra suyun sıcaklığında meydana gelen değişmeyi kaydeder.

b. 10 dakika sonra suyun hacminde meydana gelen değişmeyi ölçer.

c. 10 dakika sonra alevin sıcaklığını ölçer.

d. Bir litre suyun kaynaması için geçen zamanı ölçer.

24. Ahmet, buz parçacıklarının erime süresini etkileyen faktörleri merak etmektedir. Buz parçalarının büyüklüğü, odanın sıcaklığı ve buz parçalarının şekli gibi faktörlerin erime süresini etkileyebileceğini düşünür. Daha sonra şu hipotezi sınamaya karar verir: Buz parçalarının şekli erime süresini etkiler. Ahmet bu hipotezi sınamak için aşağıdaki deney tasarımlarının hangisini uygulamalıdır?

a. Her biri farklı şekil ve ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

b. Her biri aynı şekilde fakat farklı ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

c. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

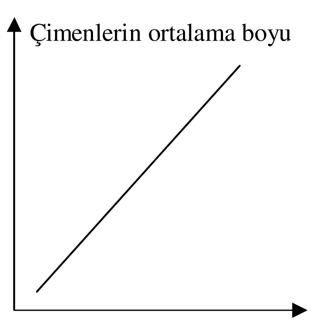
d. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar farklı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

25. Bir araştrmacı yeni bir gübreyi denemektedir. Çalışmalarını aynı büyüklükte beş tarlada yapar. Her tarlaya yeni gübresinden değişik miktarlarda karıştırır. Bir ay sonra, her tarlada yetişen çimenin ortalama boyunu ölçer. Ölçüm sonuçları aşağıdaki tabloda verilmiştir.

Gübre miktarı (kg)	Çimenlerin ortalama boyu (cm)
10	7
30	10
50	12
80	14
100	12

Tablodaki verilerin grafiği aşağadakilerden hangisidir?

a)



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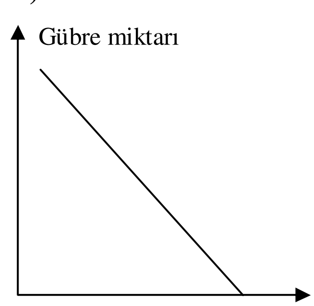
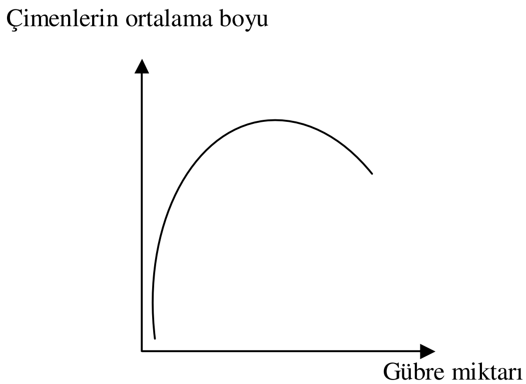
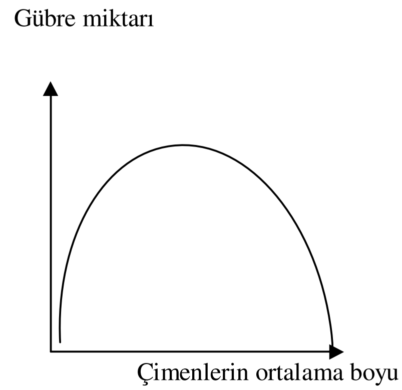


c)



d)



26. Bir biyologu hipotezi test etmek ister: Farelere ne kadar çok vitamin verilirse o kadar hızlı büyürler. Biyolog farelerin büyüme hızını nasıl ölçebilir?

a. Farelerin hızını ölçer.

b. Farelerin, günlük uyumadan durabildikleri süreyi ölçer.

c. Her gün fareleri tartar.

d. Her gün farelerin yiyeceği vitaminleri tartar.

27. Öğrenciler, şekerin suda çözünme süresini etkileyebilecek değişkenleri düşünmektedirler. Suyun sıcaklığını, şekerin ve suyun miktarlarını değişken olarak saptarlar. Öğrenciler, şekerin suda çözünme süresini aşağıdaki hipotezlerden hangisiyle sınayabilir?

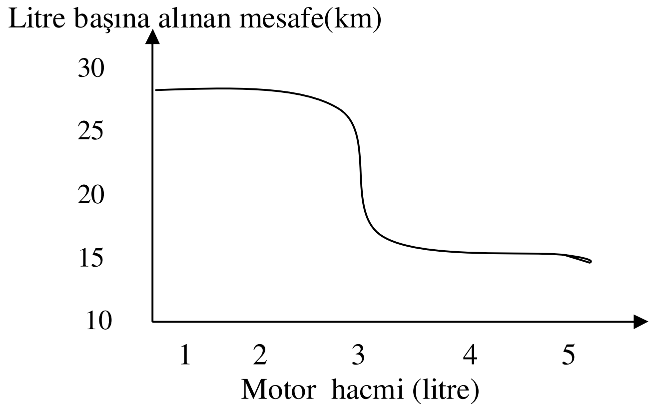
a. Daha fazla şekeri çözmek için daha faza su gereklidir.

b. Su soğudukça, şekeri çözebilmek için daha fazla karıştırmak gerekir.

c. Su ne kadar sıcaksa, o kadar çok şeker çözünecektir.

d. Su ısındıkça şeker daha uzun sürede çözünür.

28. Bir araştıma grubu, değişik hacimli motorları olan arabaların randımanlarını ölçer. Elde edilen sonuçların grafiği aşağıdaki gibidir:



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi gösterir?

a. Motor ne kadar büyükse, bir litre benzinle gidilen mesafe de o kadar uzun olur.

b. Bir litre benzinle gidilen mesafe ne kadar az olursa, arabanın motoru o kadar küçük demektir.

c. Motor küçüldükçe, arabanın bir litre benzinle gidilen mesafe artar.

d. Bir litre benzinle gidilen mesafe ne kadar uzun olursa, arabanın motoru o kadar büyük demektir.

29, 30, 31 ve 32 nci soruları aşağıda verilen paragraf okuyarak cevaplayınız.

Toprağa karıştırılan yaprakların domates üretimine etkisi araştırılmaktadır. Araştırmada dört büyük saksıya aynı miktarda ve tipte toprak konulmuştur. Fakat birinci saksıdaki torağa 15 kg., ikinciye 10 kg., üçüncüye ise 5 kg. çürümüş yaprak karıştırılmıştır. Dördüncü saksıdaki toprağa ise hiç çürümüş yaprak karıştırılmıştır . Daha sonra bu saksılara domates ekilmiştir. Bütün saksılar güneşe konmuş ve aynı miktarda sulanmıştır. Her saksıdan elde edilen domates tartılmış ve kaydedilmiştir.

29. Bu araştırmada sınanan hipotez hangisidir?

a. Bitkiler güneşten ne kadar çok ışık alırlarsa, o kadar fazla domates verirler.

b. Saksılar ne kadar büyük olursa, karıştırılan yaprak miktarı o kadar fazla olur.

c. Saksılar ne kadar çok sulanırsa, içlerindeki yapraklar o kadar çabuk çürür.

d. Toprağa ne kadar çok çürük yaprak karıştırılırsa, o kadar fazla domates elde edilir.

30. Bu araştırmada kontrol edilen değişken hangisidir?
a. Her saksıdan elde edilen domates miktarı.
b. Saksılara karıştırılan yaprak miktarı.
c. Saksılardaki toprak miktarı.
d. Çürümüş yaprak karıştırılan saksı sayısı.

31. Araştırmadaki bağımlı değişken hangisidir?
a. Her saksıdan elde edilen domates miktarı.
b. Saksılara karıştırılan yaprak miktarı.
c. Saksılardaki toprak miktarı.
d. Çürümüş yaprak karıştırılan saksı sayısı.

32. Araştırmadaki bağımsız değişken hangisidir?
a. Her saksıdan elde edilen domates miktarı.
b. Saksılara karıştırılan yaprak miktarı.
c. Saksılardaki toprak miktarı.
d. Çürümüş yaprak karıştırılan saksı sayısı.

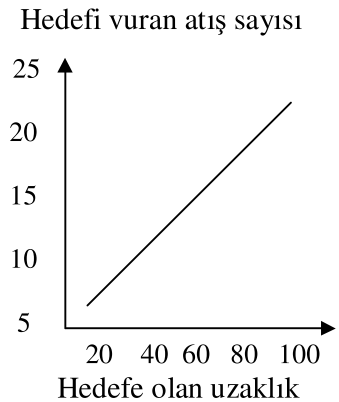
33. Bir öğrenci mıknatısların kaldırma yeteneklerini araştırmaktadır. Çeşitli boylarda ve şekillerde birkaç mıknatıs alır ve her mıknatısin çektiği demir tozlarını tartar. Bu çalışmada mıknatısın kaldırma yeteneği nasıl tanımlanır?
a. Kullanılan mıknatısın büyüklüğü ile.
b. Demir tozlarını çeken mıknatısın ağırlığı ile.
c. Kullanılan mıknatısın şekli ile.
d. Çekilen demir tozlarının ağırlığı ile

34. Bir hedefe çeşitli mesafelerden 25’ er atış yapılır. Her mesafeden yapılan 25 atış tan hedefe isabet edenler aşağıdaki tabloda gösterilmiştir.

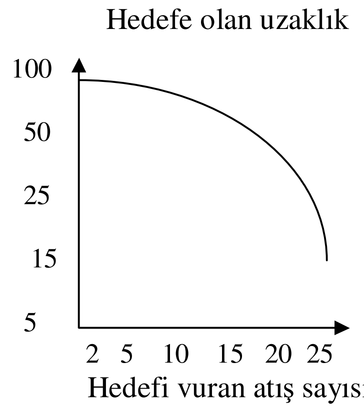
Mesafe (m)	Hedefi vuran atış sayısı
5	25
15	10
25	10
50	5
100	2

Aşağıdaki grafiklerden hangisi verilen bu verileri en iyi şekilde yansıtır?

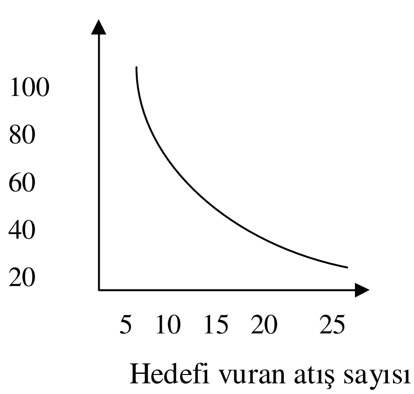
a)



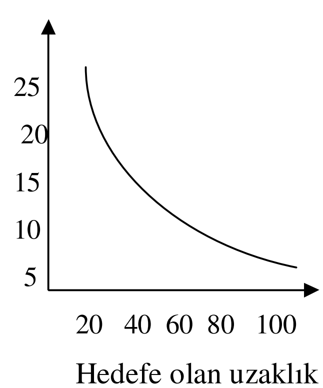
b)



c)



d)



35. Sibel, akvaryumdaki balıkların bazen çok hareketli bazen ise durgun olduklarını gözler. Balıkların hareketliliğini etkileyen faktörleri merak eder.Balıkların hareketliliğini etkileyen faktörleri hangi hipotezle sınayabilir?

a. Balıklara ne kadar çok yem verilirse, o kadar çok yeme ihtiyaçları vardır.

b. Balıklar ne kadar hareketli olursa o kadar çok yeme ihtiyaçları vardır.

c. Suda ne kadar çok oksijen varsa, balıklar o kadar iri olur.

d. Akvaryum ne kadar çok ışık alırsa, balıklar o kadar hareketli olur.

36. Murat Bey'in evinde birçok elektrikli alet vardır. Fazla gelen elektrik faturaları dikkatini çeker. Kullanılan elektrik miktarını etkileyen faktörleri araştırmaya karar verir. Aşağıdaki değişkenlerden hangisi kullanılan elektrik enerjisi miktarını etkileyebilir?

a. TV nin açık kaldığı süre.

b. Elektrik sayacının yeri.

c. Çamaşır makinesinin kullanma sıklığı.

d. a ve c

APPANDIX F

CONCEPTUAL CHANGE TEXTS

F.1. What is the Difference of Atom, Ion and Molecule?

Most of the people have difficulties in understanding of science issues. Students may interpret the new knowledge wrongly and they may have misconceptions in the learning process. Students have some misconceptions on chemical bonds. One of the reason these misconceptions are the students' insufficient knowledge related to atom, molecule and ions. So, concept of atom, molecule and ion explained before the chemical bond instruction. Teacher asked "what is the mean of atom?" The purpose of the question is to activate students' existing ideas and identify their preconceptions. The students discuss the question and the teacher guides the students during the discussion. Teacher hangs on the atom and molecule poster on the blackboard. Then the students makes molecule models by using coloured beads and fibers. Teacher controls the students' models and guide them while making it.

There are two or more atom in molecule. Molecules of the elements have the same atom, but molecules of the compounds have different atoms.

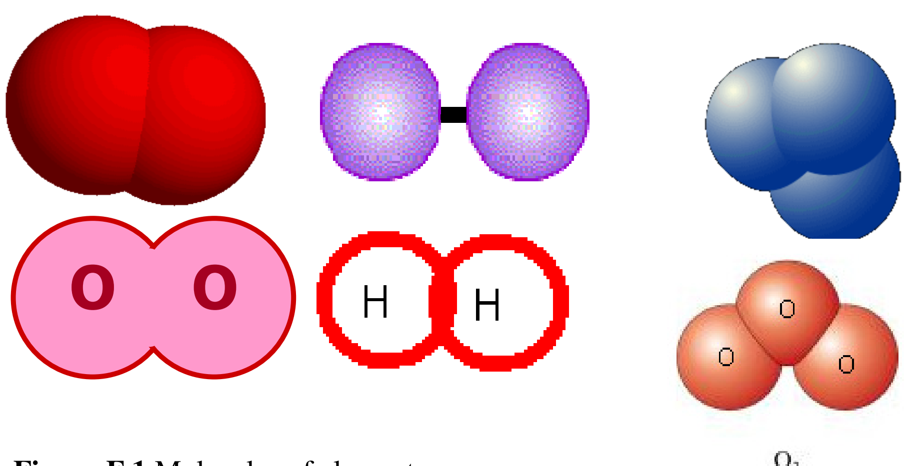


Figure F.1 Molecules of elements

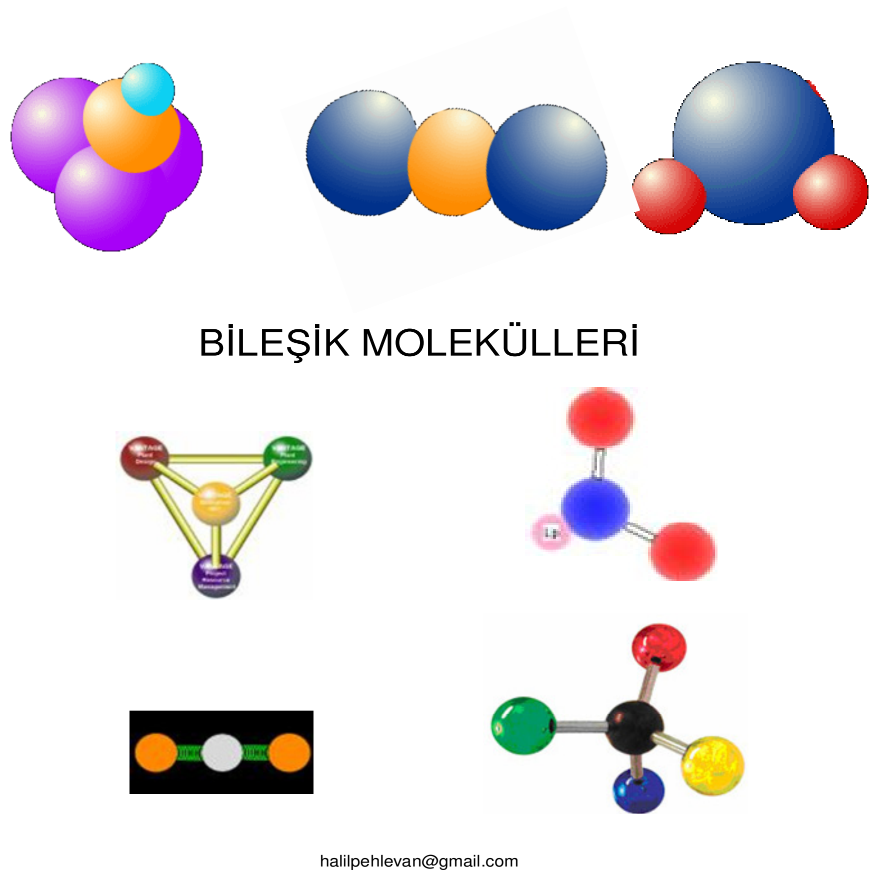


Figure F.2 Molecules of compounds

Teacher showed the poster and emphasized that the atom is the single particles but the molecules are the group of atoms. Students examined the pictures and they realize the difference of the atom and molecule in order to differentiate the atom and ion concepts. The teacher used the tale which is related atom and ion. In the light of tale students answered the questions related to atom, ion, cation and anion. Then the teacher asked the question " what is the difference of atom and ion" . Students discuss the question and the teacher showed a model which represents the ion of magnesium and neuter magnesium. Teacher wanted students to focus on the number of proton and number of electron of the magnesium ion and magnesium atom. Students realized that the number of electron for neuter magnesium and magnesium ion is different but number of proton is the same. Then teacher explain that if an atom gives electron or take electron, it became ion. Then the activity A activity B and activity C are applied in the class and the question discussed by the students.

F.2. What is the Octet Rule?

When the teacher was explaining the octet rule, she used the tools which were given in the picture. There were plastic tubes and there were colored beads. In this analogy beads are electrons and tubes are the orbits of electrons. While the teacher was using this tool, she emphasized that the there are no orbits in reality. Then the beads were placed to the tubes. While the students were putting the beads to the tubes, they showed that the first tube has taken only two beads, the second tube has taken eight tubes and the third, the fourth tubes also have taken eight beads. Teacher asked that why we can not put 3 and more beads in the first tube ? Students answered that the first tube has an limit and it can not take 2 or more beads in it. Then the teacher asked that why we can not put 9 and more beads in the second tube? Students answered this question like the first question. Then the teacher explained the octet rule and the activity F was done by the students.

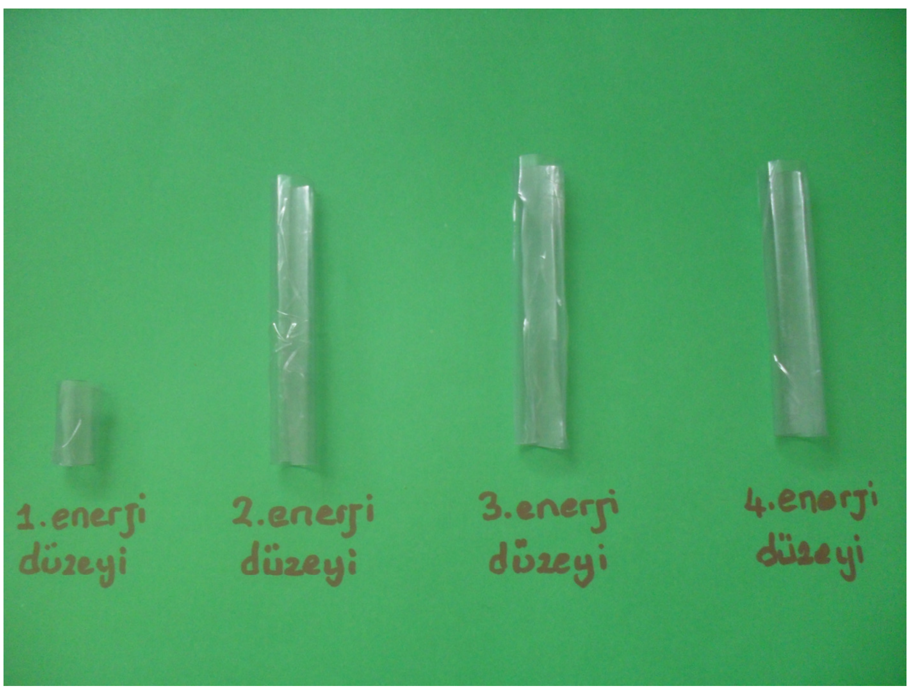


Figure F.3 Explanation of Octet Rule by Analogy

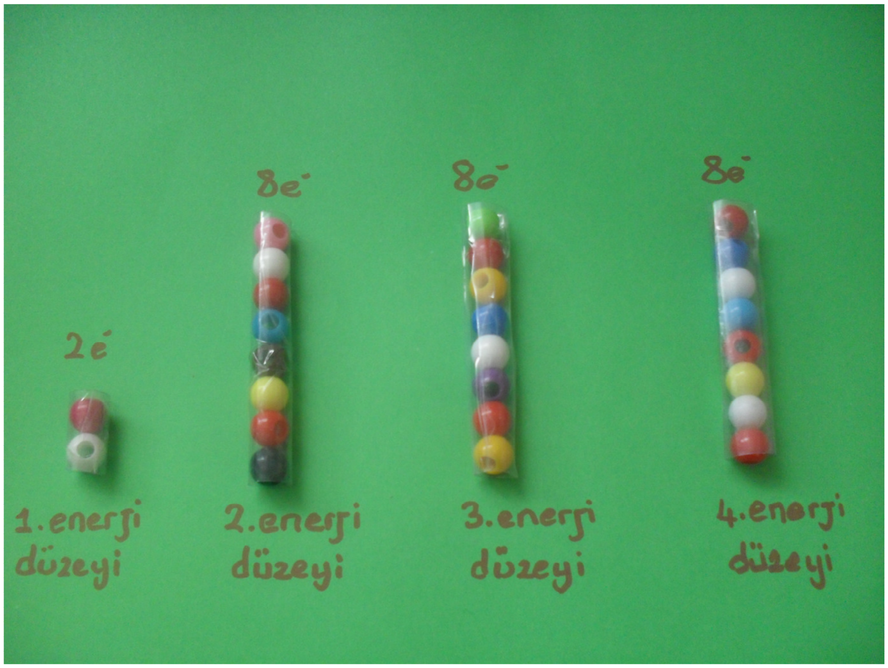


Figure F.4 Showing Analogy for Octet Rule

F.3 What is the Chemical Bond?

We use the 'bond' in different meaning in daily life. Students thinks that bond is physical things like stick, fiber and they think that bonds are 'things' which holds atoms together but they could not explain how it is occur. In order to eliminate these ideas; the teacher asks a question: What do you think what a chemical bond means? The purpose of the question is to activate students' existing ideas and identify their preconceptions. The students discuss the question and the teacher guides the students during the discussion. By this way students saw their existing ideas. Discussion is important in terms of causing students to have cognitive conflict according to Posner et al.'s (1982) conceptual change model. During discussions, students became aware of their ideas and saw some inconsistencies or gaps in their reasoning and therefore dissatisfaction occurred. Based on their answers, she explained the concept. She identified that we can not see chemical bonds with our eyes or we can not touch bonds with our hands. She emphasized on common misconceptions and the topics in which students had difficulty. She used analogies in order to make concepts more concrete.

Figure F.5 Analogy for Chemical Bond

This analogy makes a connection between the chemical bond and the solar system. In the solar system, the planets replace in a determined situation thanks to the force that sun applied for the planets. Teacher show the solar system picture and explain that in solar system, the sun apply force to the planets. This force between the planets and the sun is a force that holds atoms of elements together in a compound. Most students think wrongly that chemical bonds are material connections simply. However, when we think scientifically, we see that there are forces that hold the atoms of elements together in a compound. These forces are called as "chemical bonds". In other words, the "thing" between atoms you mentioned is the electrostatic forces that hold the atoms together. The type and strength of chemical bonds determine the properties of a substance. (Then second analogy is used) For example;

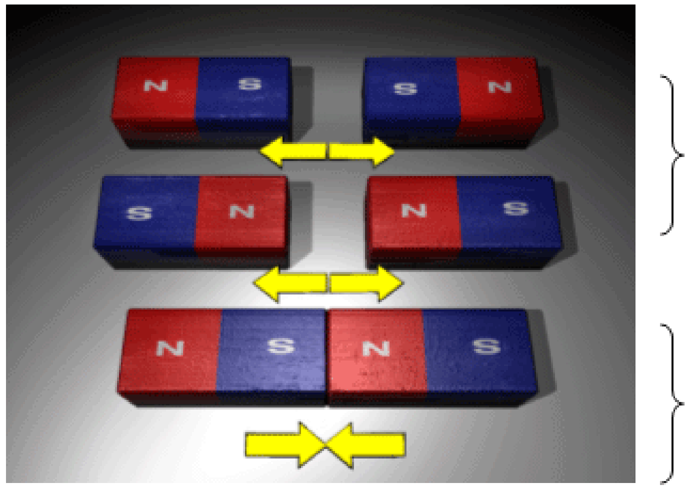


Figure F.6 Analogy for Explaining Attractions of Atoms

The same poles of magnets repel each other but the unlike poles attract each other. Atoms are electrically charged, so that reason they attract or or repel like the poles of the magnets. These attractions between the particles of atoms leads to chemical bond and atoms hold together.

This step supports conceptual change described by Posner et al. (1982). Teacher defined clearly what is a chemical bond by using magnets and solar system and she emphasized interactions and she focused on students' existing knowledge. Thus, the concept became intelligible and plausible for the students. Also, students realized that they could use their explanation for finding solutions to other questions; by this way, fruitfulness was achieved. After that the teacher asks that "What do you think why chemical bonds form?" The purpose of the teacher was to activate students prior knowledge related to chemical bond. Then the students discuss the questions.

F.4 Why Does Chemical Bond Occur?

After this step teacher asked a new question again which was: What do you think why does chemical bond occur? The purpose was to activate students' prior knowledge and found their preconceptions.

Most of the students think that atom wants to fill its octet in order to looks like noble gas and atoms make bond only to fill their octet. Teacher used the analogy for stability.

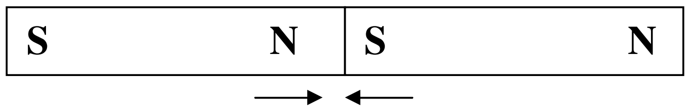


Figure F.7 Analogy for Explaining Stability of Atoms

In this picture, there is a strong attraction force between them but there is low potential energy. Teacher showed the magnets like the picture. Then she explained that when we put closer the unlike poles of two magnets to each other, an attraction force between the magnets occurs. So we must give energy in order to pull them apart. Teacher asked the question which was "What happens to given energy after parting?"(Teacher used the magnets again like the picture)

Figure F.8 Analogy for Explaining Energy of Atoms

In this picture, there is a strong attraction force between them but there is low potential energy. The question discussed among the students then teacher explain that energy never lost, it is taken by magnets and it cause increasing the potential energy of unlike poles. When separated the magnets are leaving off, they naturally come closer. By this way, their potential energies decrease again. Because, they give energy to their surrounding. Additionally, they became more stable.
After this step teacher asked a new question again which was: What will happen when the same poles of two magnets are put closer to each other? (Teacher used the magnets again like the picture) After students discussed the question, the teacher

explain that strong repulsive force occur between the magnets, so energy must be given to keep them closer to each other.

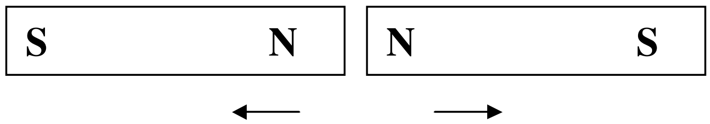


Figure F.9 Analogy for Explaining High Potential Energy of Atoms

In this picture, there is a strong repulsive force and high potential energy. When we seperated the magnets, they will leave naturally by using given energy. Then they became more stable and low potential energy. Teacher makes the analogy for stability and the magnets. Like magnets, everything in nature wants to have low potential energy and tend to became more stable. Atoms and molecules also have potential energy and this works similar to the potential energy of the magnets.

F.5 What is the Ionic Bond?

Most of the students think that ionic bonds are only the transfer of electrons, rather than the attractions of the ions that result from the transfer of electrons. Students misinterpret the definition of the chemical bond, so misconception occurs in their mind. Teacher asked the question which was: “what is ionic bond?” students discussed the question. Then the teacher used the analogy for ionic bond. She used the following pictures while explaining ionic bond.

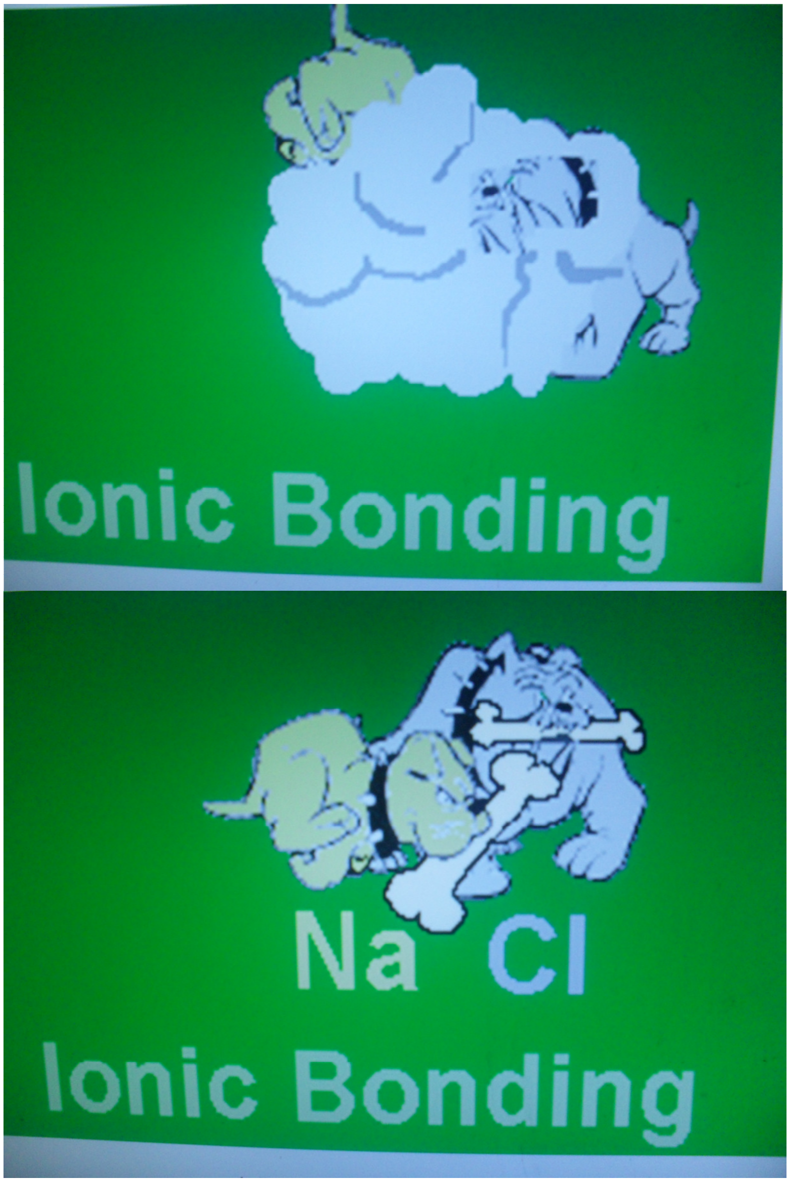


Figure F.10 Analogy for Ionic Bond

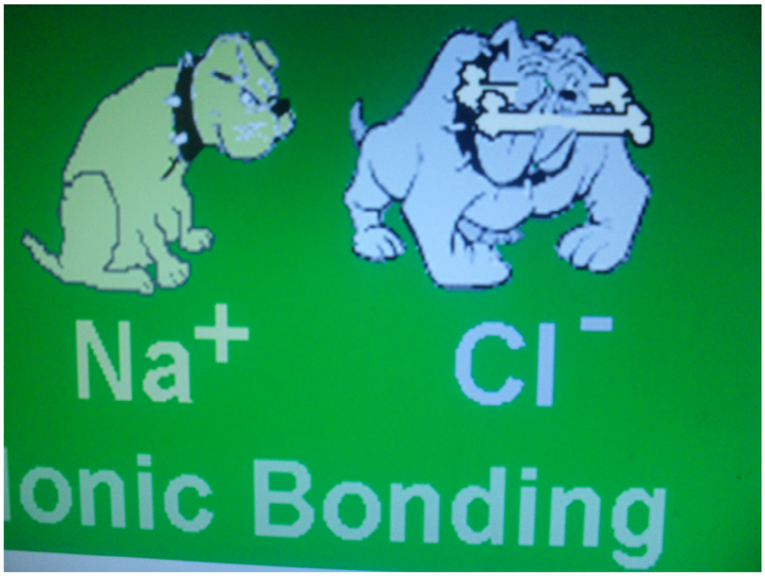


Figure F.11 Analogy for Ionic Bond and Electron Transfer

There are two dogs in the picture. Two of them want to take the bone. Dogs fighted for the bones and the big greedy dog are steeling the other dog's bone. The bone represents the electron in this analogy. The big dog gains an electron he becomes negatively charged and the little dog that lost the electron becomes positively charged. The two ions are attracted very strongly to each other. Ionic bond is the attractive force between oppositely charged ions in an ionic compound.

After showing the analogy, the teacher used this model and explain the ionic bond according to Na and Cl atoms.

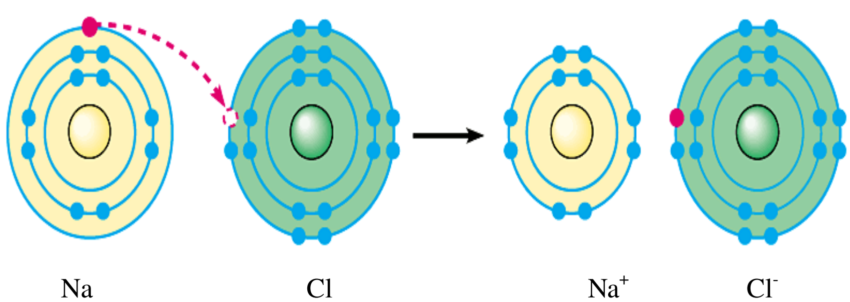


Figure F.12 Example for Ionic Bond

F.6 What is the Covalent Bond?

Most of the students think that bonding occurs only between atoms that give and accept electrons, which were also stated as a misconception in literature. Then, the teacher asked another question to the groups in order to create cognitive conflict, which was: How does bonding occur between Hydrogen and Chloride atoms leading HCl molecule? The students could not explain this situation. In this way, Posner et al.'s first condition (dissatisfaction) was enhanced. Most of the students think that covalent bond is sharing electrons and it holds atoms together. In reality, the attractive force between shared electrons and nuclei of the atoms is a covalent bond. Then the teacher used the following pictures for covalent bond analogy.

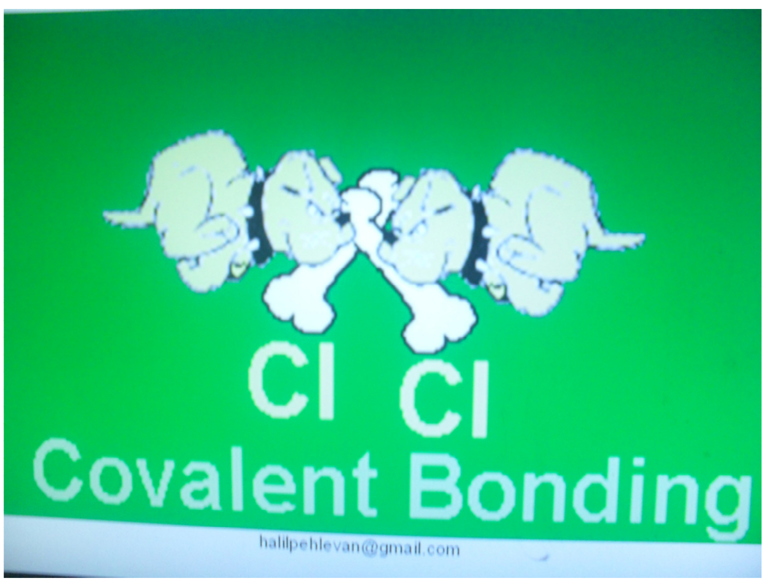


Figure F.13 Analogy for Covalent Bond

Figure F.14 Analogy for Covalent Bond and Electron Sharing

There are two dogs in the picture. Two of them want to take the bone. Dogs have equal strength. Covalent bonds can be thought of as two or more dogs with equal attraction to the bones. In this analogy, the dogs represent the atoms and the dogs are identical. They want to share the pairs of available bones. One dog does not have more of the bone than the other dog so that reason, the charge is evenly distributed between both dogs. This covalent bond is called non polar covalent bond. The molecule is not "polar" meaning one side does not have more charge than the other. Then the teacher showed the example non polar covalent bond to the students and explains the non polar covalent bond.

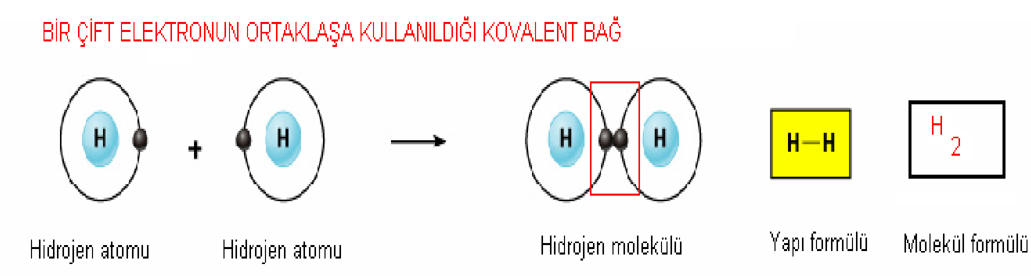


Figure F.15 Example 1 for Covalent Bond

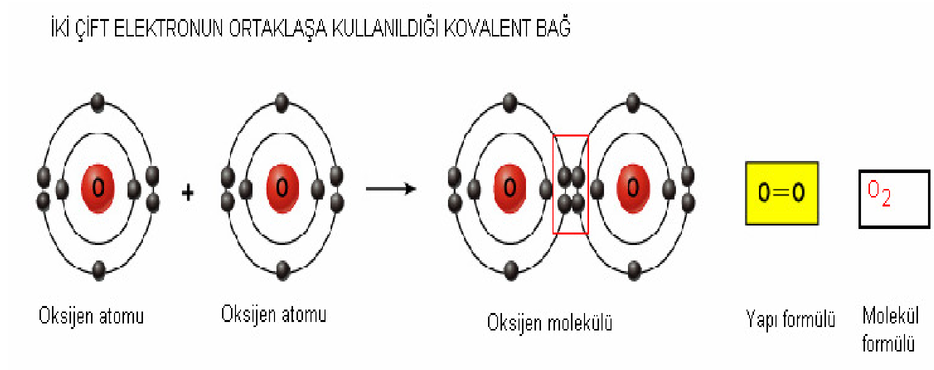


Figure F.16 Example 2 for Covalent Bond

In order to explain the polar covalent bond teacher used the following pictures. Teacher said that you know that similar nonmetals make covalent bond. Then she asked that 'Do different nonmetals make covalent bond?' Some of the students answered that yes and some of them answered no. Then the teacher showed the pictures.

Figure F.17 Analogy for Polar Covalent Bond

Figure F.18 Analogy 2 for Polar Covalent Bond

Let's look at the following picture. In this picture, Dogs have not equal strength. One of them is stronger than the other so it pulls more strongly than the other dog. This bone sharing similar to sharing electrons pairs between the atoms that have different electro negativity in covalent bonding. Then the teacher showed the following picture and she explained that Covalent bonds can be classified as non polar covalent bond and polar covalent bond. A non polar covalent bond forms when electrons are shared equally between atoms and a polar covalent bond forms when electrons are not shared equally. In polar bonds, the shared electrons tend to be pulled closer to more electronegative atom than to the other. The teacher also focused on the meaning of "electron sharing" used for explaining covalent bonding. Students think that social meaning of sharing which implies equality. So, they believe that electrons are used equally between atoms in all covalent bonds. in other words, all covalent bonds are non polar. But like the examples, polar covalent bond may be occur between the atoms. Activity G, H and J are used.

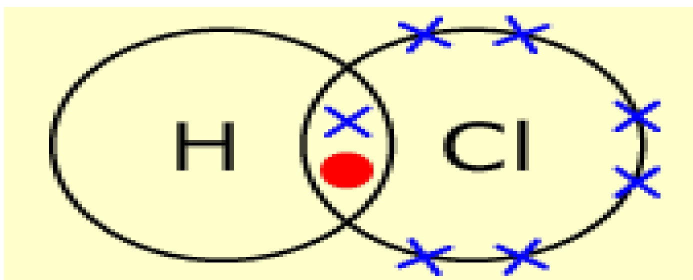


Figure F.19 Example for Polar Covalent Bond

F.7 What is the Basic Properties of the Group of the Elements in Periodic Table?

Most of the students have difficulties on properties of groups in periodic table. They used their previous knowledge related to structure of atoms and properties of periodic table. Most of the students believed that metals want to give electron and nonmetals want to take electrons, as a result, chemical bond occurs. In order to eliminate the misconception related to periodic table, activity D and E which is a tale making an analogy with periodic table is used. After students read the tale, teacher asked the questions related to tale. Then students discuss the question and the teacher guides them. Teacher activated students existing knowledge by asking questions. After the discussion students reach the common answer related to topic. Then the teacher explains the properties of periodic table.

F.8 What is the Difference of Ionic and Covalent Compound?

Most of the students think that ionic and covalent compound have the same properties only their bond is different.

Ionic compounds have cations and anions and they held together by the electrical attraction of opposite charges (ionic bonds). There are example of H_2O and sodium chloride (HCl) in the picture. Teacher showed the covalent compounds picture and she asked that “have you ever seen ions in this picture?” Students realize that the covalent compounds have not ions they have only molecules and on the contrary, ionic compounds have not molecules but they have ions. After that teacher asked that “what is the particles of ionic compounds and covalent compounds?” Students answered that the particles of covalent compounds are molecule and particles of ionic compounds are ions. Students prepare the ionic and covalent compound models by using colored beads. Then, activity I is done.

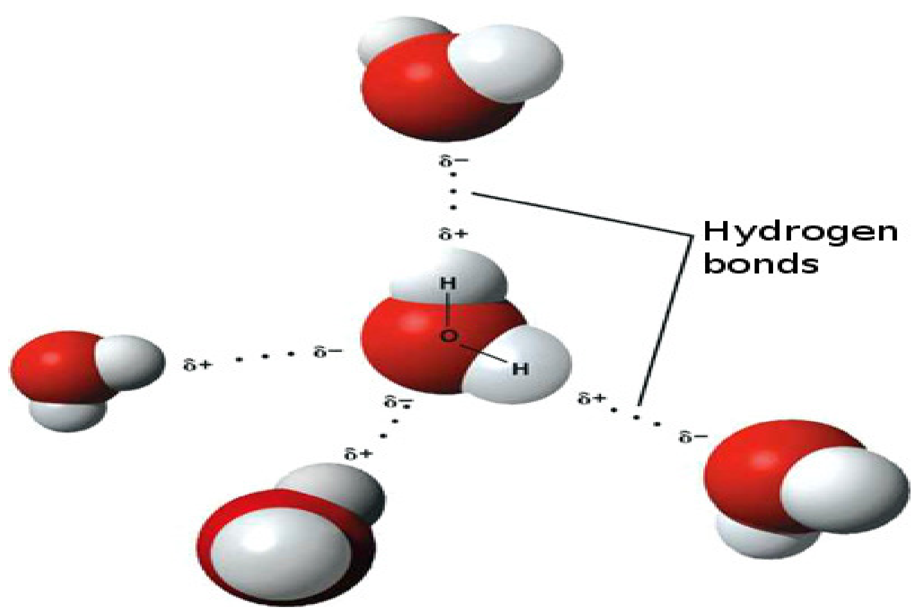


Figure F.20 Example of Covalent Compound

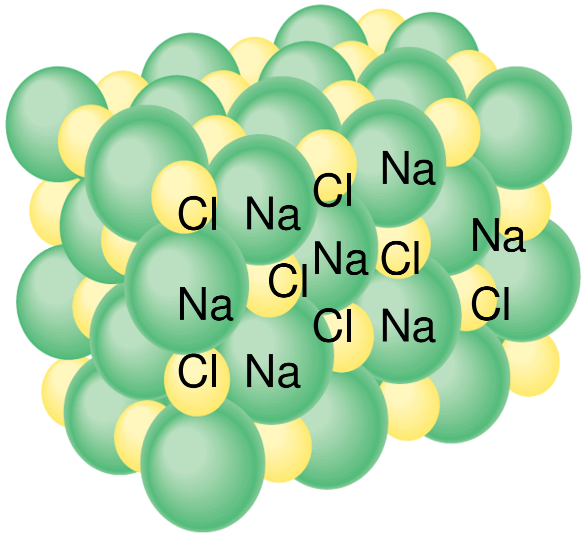


Figure F.21 Example of Ionic Compound

F.9 Activity A

Merhaba, benim adım atom, ben doğada gördüğün birçok maddenin içinde bulunurum. Bizim atom evi denilen bir evimiz var etrafında da çok güzel bir bahçemiz var. Evimizin içinde proton hanım ve nötron bey kalırlar. Yüz yıllar önce kötü bir cadı bir büyü yapmış. Bu büyü, proton ile nötronun evden dışarı çıkmalarını yasaklanmış eğer herhangi bir şekilde evden çıkarlarsa atom evi yok olacakmış. Bu nedenle her ikisi de evden kesinlik dışarı çıkmaz hareket etmezlermiş. Evin bahçelerinde ise yaramaz elektronlar bulunurmuş. Bunlar o kadar yaramazlarmış ki hiç yerinde duramaz sürekli bahçeleri içerisinde koşuştururlarmış. Eğer kendi bahçelerine dışarıdan elektron gelirse; diğer elektron hep alıyon alıyon elektron alıyon diyerek şarkı söylerlermiş ve bu nedenle de elektron alan atom evlerine anyon denirmiş. Kendi bahçelerinden elektron gittiğinde de elektron hep atıyon atıyon elektron atıyon diyerek şarkı söylerlermiş ve bu nedenle de elektron veren atom evlerine katyon denirmiş. Anyon ve katyon evleri kendilerini diğer atom evlerinde hep farklı görürlermiş ve kendilerine iyon evler derlermiş. İyon ev olan atom evleri kendilerini daha asil hissettikleri için hep anyon ya da katyon durumuna geçmek için sürekli elektron alır ya da verirlermiş.
Hikâyeye göre aşağıdaki soruları cevaplayınız.

1. Atomun hangi tanecikleri hareket etmez?

…………………………………………………………………………………….

2. Atomun hangi tanecikleri hareket eder?

…………………………………………………………………………………….

3. Bahçeden elektron gidince elektronlar ne söylüyorlar? Buna göre elektron vermiş atoma ne denir?

……………………………………………………………………………………..

4. Bahçeye elektron gelince elektronlar ne söylüyorlar? Buna göre elektron almış atoma ne denir?

……………………………………………………………………………………

5. Atom ile iyonun farkı nedir?

……………………………………………………………………………………

F.10 Activity B

Aşağıda iyon ağacı verilmiştir. Anyonları anyon sepetine, katyonları katyon sepetine yerleştiriniz.

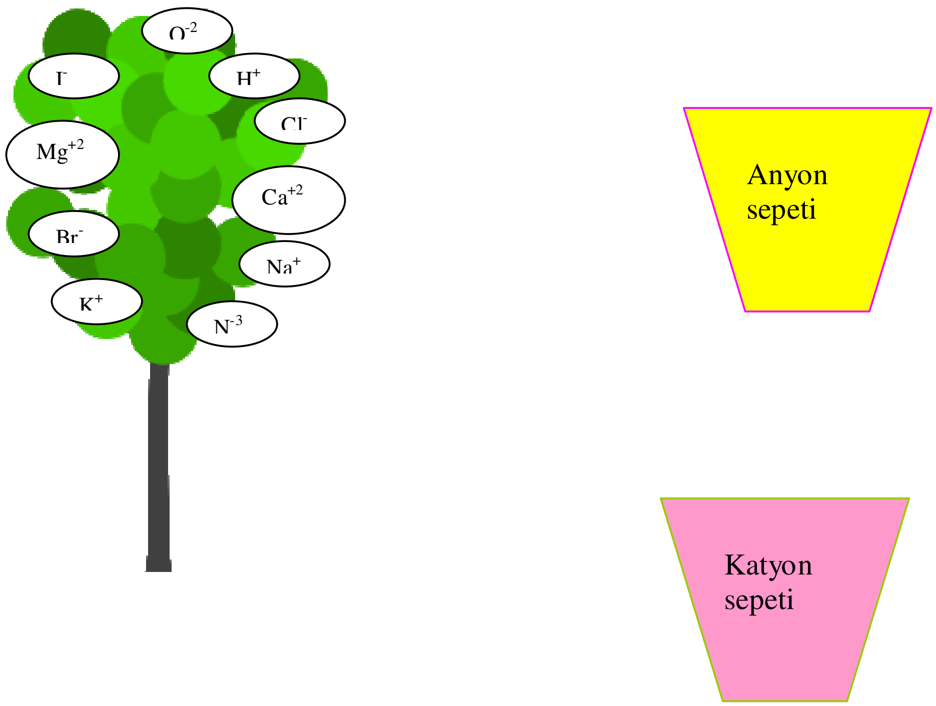


Figure F.22 Tree of Ions

Sepetlere yerleştirdiğiniz elementleri kullanarak hangi elemenler arasında iyonik bağ oluşabileceğinizi yazınız. Sebebini belirtiniz.

……………………………………………………………………………………………

……………………………………………………………………………………………

Sepetlere yerleştirdiğiniz elementleri kullanarak hangi elemenler arasında kovalent bağ oluşabileceğinizi yazınız. Sebebini belirtiniz.

……………………………………………………………………………………………

……………………………………………………………………………………………

F. 11 Activity C

Aşağıda verilen elementlerin proton, elektron sayılarını, yüklerinin, anyon/katyon olma durumunu belirtiniz.

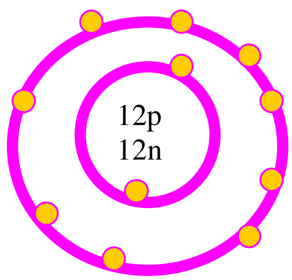


Figure F.23 First Example for Ion

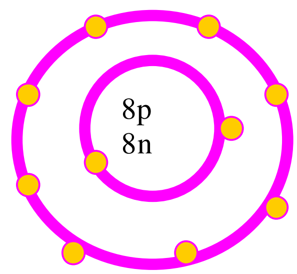


Figure F.24 Second Example for Ion

Proton:
Elektron:
yük:
Anyon/katyon:

proton:
elektron:
yük:
Anyon/katyon:

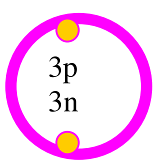


Figure F.25 Third Example for Ion

Proton:
Elektron:
yük:
Anyon/katyon:

F.12 Activity D

Çok eski yıllar önce küçük bir ülke varmış. Bu ülkede elementler yaşarlarmış. Bu ülkenin padişahı çok asilmiş. Kendisi diğer asiller gibi asiller şehrinde yaşar ve ülkesini yönetirmiş. Ülkenin yasalarına göre asiller dışında başka hiçbir element padişah olamazmış. Bu nedenle Alkali şehri, toprak Alkali şehri ve Halojenler şehrinde yaşayan diğer elementler bir gün asiller gibi olabilmek için kendilerini onlara benzetmeye çalışırlarmış. Her şehirde yaşayan element grupları benzer özelliklere sahip oldukları için şehirlerini terk etmez aynı şehirde yaşarlarmış. Bir gün bu ülkeye bir yabancı gelmiş ve ülkeyi gezmeye başlamış. Yabancının yolu üzerindeki ilk şehir, metallerin yaşadığı Alkali şehiriymiş. Buraya geldiğinde çok şaşırmış. Çünkü metallerin hiçbiri birbirleri ile konuşmuyorlarmış. Yoldan geçen sodyum elementine neden kimsenin birbiri ile konuşmadığını sormuş. Sodyum elementi ona şu cevabı vermiş. 'Biz metaller ancak ametal arkadaşlarımız ile görüştüğümüz zaman bir asile benziyoruz bu nedenle kendi aramızda kesinlikle konuşmuyoruz ve görüşmüyoruz çünkü asil olamıyoruz.' Yabancı bu şehri terk edip tolu üzerindeki ikinci şehir olan Toprak Alkali şehrine gelmiş. Burada yaşayan metallerinde aynı durumda olduğunu görmüş. Bunun üzerine herkesin çok iyi anlaştığı ametallerin yaşadığı halojenler şehrine gelmiş. Buradaki elementlerin hem birbirleri ile hem de metaller ile çok iyi anlaştığını görmüş ve onları takdir etmiş. Onlara umarım bir gün sizde kendinizi asillere benzetebilirsiniz ve emellerinize ulaşırsınız diyerek onlara veda etmiş.

Aşağıdaki boşlukları doldurunuz.

Benzetilen kavramın gerçek adı	*Hikâyedeki benzetme*
Asal gazlar	…………………
……………………	Alkali şehri
Toprak Alkali Grubu	………………….
………………………	Holojenler şehri

1. Hikayeye göre birbirleri ile anlaşamayan elementlere ne ad verilir?

……………………………………………………………………………………..

2. Hikayeye göre hem kendi aralarında hem de metaller ile çok iyi anlaşan elementlere ne ad verilir?

………………………………………………………………………………………..

3. Hikayeye göre ülkede yaşayan metal ve ametal elementleri kendilerini kimlere benzetmeye çalışırlar?

…………………………………………………………………………………………

F.13 Activity E

1A	2A																8A
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al		P	S	Cl	Ar
K	Ca				Cr		Fe		Ni	Cu	Zn						
										Ag			Sn			I	
										Au	Hg		Pb				

Aşağıdaki kutularda sarı olanlar metal, pembeler ametal ve mavi olanlarda soygaz olan elementlerdir. Bunları periyodik tobloda yerlerine yerleştiriniz. Bu kutuları kullanarak, iyonik ve kovalent bağ oluşturunuz. (Hidrojen katyon olmasına rağmen ametaldir)

bakır	lityum	sodyum	magnezyum	berilyum	kalsiyum	aliminyum	Potasyum	
çinko	demir	nikel	krom	gümüş	altın	civa	kurşun	kalay
karbon	Azot	Flor	kükürt	oksijen	Neon	klor	fosfor	
Helyum	Iyot	Hidrojen	Bor	Argon				

Figure F. 26 Periodic Table and Elements

F.14 Activity F

Şekildeki kaplardan I.'si 2 top, II., III. ve IV. 'sü 8 top almaktadır. Şekilde görüldüğü gibi kapların kapasitesinden fazla topu kaplara yerleştiremeyiz. Elektronların da yörüngelerde bulunma durumu topların kaplarda bulunma durumu gibidir. Birinci yörünge de en fazla 2 elektron, ikinci yörüngede en fazla 8 elektron, üçüncü yörüngede en fazla 8 elektron, dördüncü yörüngede en fazla 8 elektron bulunur. Aşağıda atom numarası verilen elementlerin elektron dizilimini bu etkinliğe göre yapınız.

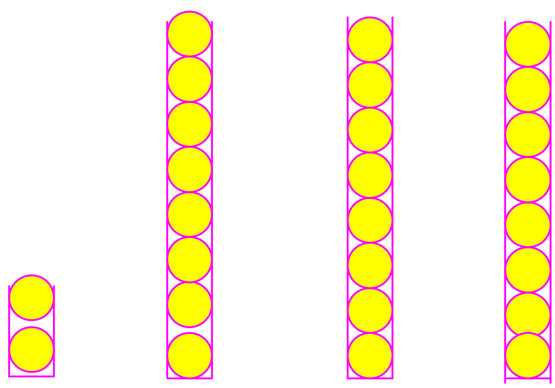
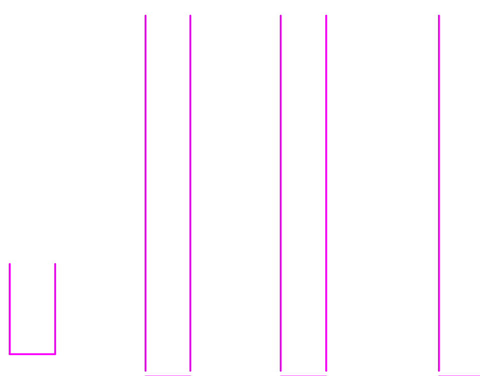


Figure F. 27 Example for Octet Rule

Atom no:11



Atom no: 6

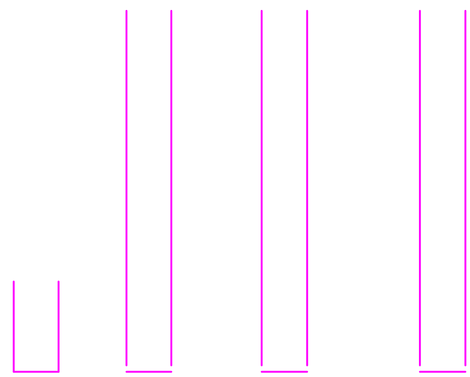


Figure F. 28 Example 2 for Electron Confuguration

F. 15 Activity G

Her birinin önünde birer metal topu asılı olan aşağıdaki mıknatıslar yan yana getirildiğinde asılı bulunan metal toplarının durumları nasıl olur? Çizerek gösteriniz.
Not: Büyük mıknatısın çekim kuvveti küçük mıknatıslardan daha fazladır.

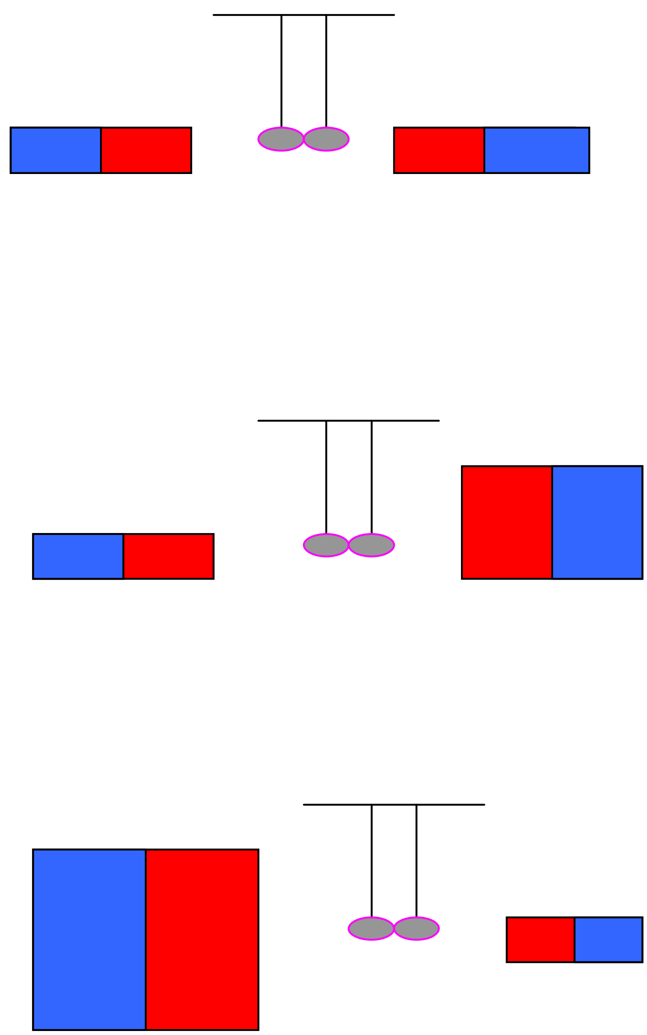


Figure F. 29 Activiy for chemical bond

Aralarında iple asılı duran iki metal topu bulunan iki mıknatıs düşünelim. Eğer mıknatısların büyüklüğü eşitse gücü de eşittir ve metal topların konumunda bir değişiklik olmaz. İkisi de eşit miktarda çekecektir. Eğer mıknatıslar birbirinden biraz farklı bir güce sahipse metal toplar daha güçlü olan mıknatısa doğru hareket edecektir. Eğer mıknatısların güçleri birbirinden çok farklı ise güçlü olan mıknatıs metal topun asılı olduğu ipten kendine doğru çekip ipi koparacaktır.

Mıknatısların güçleri aynı olduğunda metal toplar tam ortada asılı kalır. %100 kovalent bağda iki atom arasında paylaşılan elektron her iki atom tarafından da eşit miktarda ekilir.

Mıknatısların güçleri birbirinden farklı birbirinden biraz farklı olduğunda metal topu gücü fazla olan mıknatıs tarafına geçer. Farklı ametal atomları arasında paylaşılan elektron, gücü fazla olan atom tarafından daha çok çekilir.

Mıknatısların güçleri birbirinden çok farklı olduğunda metal topu gücü fazla olan mıknatıs metal topun asılı olduğu ipten kendine doğru çekip ipi koparacaktır . %100 iyonik bağda ametal atomu metal atomunun elektronunu alır.

F. 16 Activity H

Aşağıda üzerinde bileşik adları yazılı toplar verilmiştir. Eğer bileşik iyonik bağa sahip ise iyonik bağ seğetine; eğer bileşik kovalent bağa sahip ise kovalent bağ sepetine yerleştiriniz.

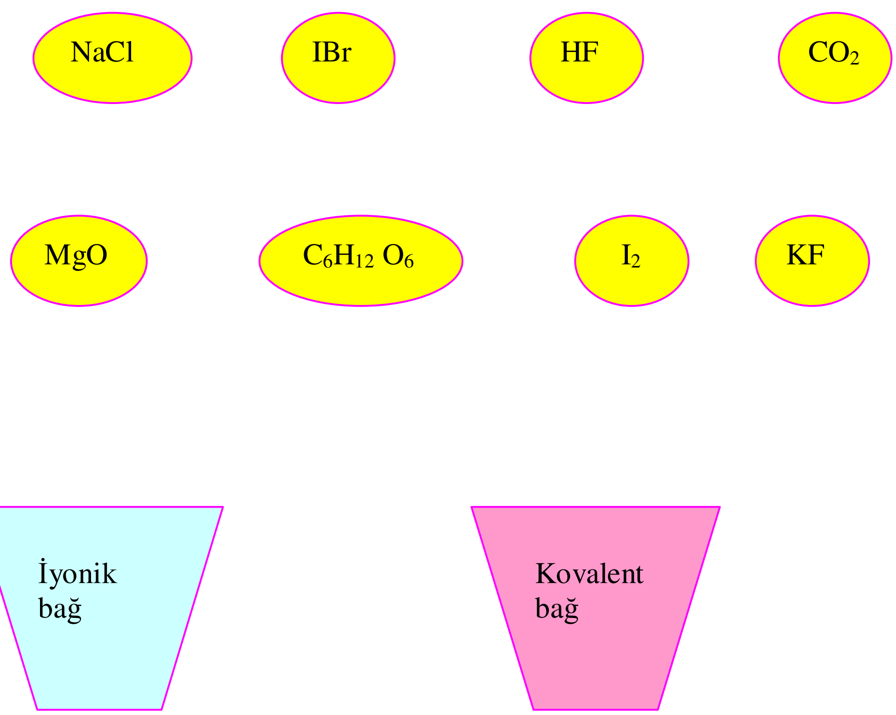


Figure F. 30 Activity for Compounds Bond Type

F.17 Activity I

Aşağıda verilen bileşik resimlerini inceleyiniz ve bileşikleri kovalent yapılı ve iyonik yapılı bileşik olarak ayırt ediniz. Her bileşiğin sahip olduğu tanecikleri iyon, molekül olarak ayırt ediniz.

I II III

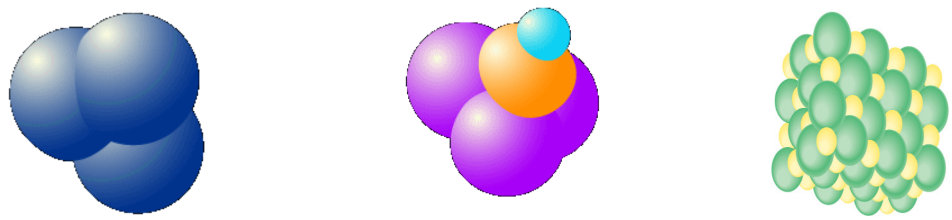


Figure F. 31 Examples of Covalent and Ionic Compounds

………………….. …………………… ……………………

…………………. …………………… ……………………

F. 18 Activity J

X_{11},Y_8, Z_4, T_{18} elementlerinin atom numarası verilmiştir. Buna göre bu elementler için aşağıdaki soruları cevaplayınız.

1. Yukarıdaki elementlerden hangisi/hangileri metaldir?

………………………………………………………………………………….

2. Yukarıdaki elementlerden hangisi/hangileri ametaldir?

………………………………………………………………………………….

3. Yukarıdaki elementlerden hangisi/hangileri soygazdır?

………………………………………………………………………………….

4. Yukarıdaki elementlerden hangisi/hangileri kovalent bağ yapar?

………………………………………………………………………………….

5. Yukarıdaki elementlerden hangisi/hangileri iyonik bağ yapar?

………………………………………………………………………………….

6. Yukarıdaki elementlerden hangileri aralarında bağ yapmaz?

………………………………………………………………………………….

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