STEM Sims™

Attractions

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Do you need an idea for a scientific study?
Try out one of our ideas or make one of your own.

Forces of attraction define how different substances react and their physical properties. Take the following brief quiz to see how much you already know about the attractions within and between molecules. See the bottom of page 4 to check your answers.

1. The temperature at which a substance changes its state of matter is an example of a:
   a. chemical property.
   b. magnetic property.
   c. physical property.
   d. radioactive property.

2. Melting and dissolving in water describe the same process.
   a. true
   b. false

3. Opposite charges:
   a. repel each other.
   b. have no effect on each other.
   c. attract each other.

4. Who is credited with publishing the irst paper that proposed chemical bonding is due to electrons being shared by two atoms?
   a. Gilbert Lewis
   b. Ernest Rutherford
   c. James Bond
   d. Albert Einstein

5. In what year did John Dalton propose the idea that all matter is made of tiny bits called atoms?
   a. 1608
   b. 1708
   c. 1808
   d. 1908

How Are They Different?

Many substances have very similar appearances but respond differently to heating. Can you find out why sugar and table salt behave differently in an oven? Get started now.

Materials Required

1 – metric ruler
1 – piece of aluminum foil (30 cm by 30 cm)
1 – marker
¼ teaspoon sugar
¼ teaspoon table salt
oven

Procedure

1. *You must have adult permission and help to complete this investigation! Do not complete this investigation on your own!*
2. *Serious burns can result from not following the directions to complete this investigation!*
3. Flatten the piece of aluminum foil and then fold up the edges of the foil as shown in Figure 1.
4. Use the marker to draw two 10-cm diameter circles on the aluminum foil as shown in Figure 1.

Figure 1.

5. Place the ¼ teaspoon of sugar in one of the circles.
6. Place the ¼ teaspoon of table salt in the other circle. In Table 1, describe the appearance of both substances.
7. Carefully place the aluminum foil in the oven. *Make sure the oven is not hot!*
8. Turn on the oven to 400 °F.
9. After about 10 minutes, turn off the oven.
10. *Without touching any parts of the interior oven or foil,* observe the sugar and salt on the foil. In Table 1, describe the appearance of both substances.
11. *Allow the oven to cool completely!*
12. Remove the aluminum foil and dispose of the foil and materials in a waste receptacle.

Table 1. Sugar and Table Salt Observations

Substance	Observations
Sugar Before Heating	
Table Salt Before Heating	
Sugar After Heating	
Table Salt After Heating	

Questions

1. Propose a reason for the way the two substances responded differently to being heated in the oven.

Attractions

A New Type of Chemical Bond

For many years, three types of chemical bonds have been assumed to characterize all interactions between atoms that hold these atoms together: metallic, covalent, and ionic. However, scientists have discovered a new type of bond called the *collective* bond associated with some compounds. In particular, the newly synthesized substance sodium borohydride ($NaBH_3^{-1}$) exhibits this new type of bond. The expected bonds in the molecule would involve covalent chemical bonds with boron being the central atom with sodium and the three hydrogen atoms connecting to the boron atom. However, the interaction between the sodium atom and the boron atom as indicated by the left red arrow in Figure 1 was *not* present as expected. Instead, the negative partial charge (δ-) on the sodium atom formed a connection with positive partial charge (δ+) on the three hydrogen atoms as shown by the blue arrow, and in the process skipped the normal interaction with the boron atom.

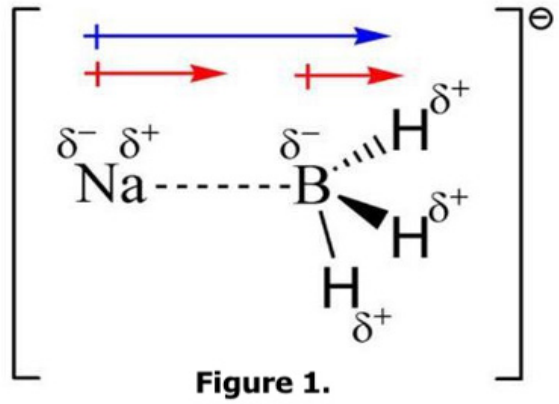

Figure 1.

The sodium borohydride ion exists because of a strong long-range interaction between sodium and the hydrogen atoms. In fact, some say that the connection between sodium and boron would act to destabilize the molecule, while the sodium-hydrogen atoms connections stabilize the molecule and result in the molecule's physical and chemical properties.

However, some researchers argue that this *collective* bond is not an entirely new type of chemical bond since the interactions between the sodium atom and the hydrogen atoms are still electrostatic in nature, thus making the interaction a typical covalent bond. What all scientists agree on is that chemical bonding between atoms to form molecules is a complex process and is not easily categorized or understood. As usual, more research is needed to solve the mysteries of strange compounds such as sodium borohydride.

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Answers: Page 2 Answers: 1) c, 2) b, 3) c, 4) a, 5) c. **Page 3 Answers: How Are They Different?** 1) The forces holding the particles in table salt together are stronger than the forces holding the sugar particles together.