

Additional Teacher Background

Chapter 6, Lesson 1, p. 471

In the reaction between methane and oxygen, why do the atoms in methane and oxygen switch around and bond to form carbon dioxide and water?

This is a very good question. One of the main reasons has to do with the attractions that protons and electrons in one atom have for the electrons and protons in other atoms. If the conditions are right and atoms get a chance to bond with different atoms so that electrons are attracted to and closer to more protons, the atoms will switch around and rebond.

In methane, the 4 hydrogen atoms are each bonded to the 1 carbon atom by a covalent bond. Remember that this bond happens because the electron from the hydrogen atom is attracted to the protons in the carbon atom and an electron from the Carbon atom is attracted to the proton in the hydrogen atom. These attractions bring the atoms together and they end up sharing electrons to form a covalent bond.

The same is true about the other reactant – the oxygen molecules. The electrons from each oxygen atom are attracted to the protons in the other oxygen atom. This is true for both atoms so they come together and share electrons to form a covalent bond.

But the big question is why do the atoms in the methane and oxygen switch around and bond to different atoms in a chemical reaction to form carbon dioxide and water?

The answer is that the electrons and protons feel stronger attractions for each other and can get closer together if they switch around and bond to different atoms. The hydrogen atoms that are bonded to the carbon atom in methane switch around and end up being bonded to oxygen atoms to make water. The electrons in the hydrogen atoms were near 6 protons in the carbon atom but are now near 8 protons in oxygen. They are more attracted to 8 protons than to 6 so the trade is good to satisfy the attractions of electrons and protons.

The carbon atom that was attracted to the hydrogen atoms in the methane switched around and is now bonded to 2 oxygen atoms in the carbon dioxide. This is a really good trade. The electron from the carbon atom was near 1 proton from a hydrogen atom is now near 8 protons from an oxygen atom. This also satisfies the attractions of electrons and protons.

So one of the main reasons why atoms rearrange themselves in a chemical reaction is that by bonding to the other atoms, electrons and protons feel more attraction and get closer together.

Note:

This explanation works well for combustion reactions and other exothermic reactions but cannot fully explain endothermic reactions. In endothermic reactions, the electrons and protons in the products are actually in a less favorable situation for mutual attraction than they were in the reactants. There is a concept called entropy which helps explain why endothermic reactions occur but concepts related to entropy are beyond the scope of middle school chemistry and will not be introduced in this material.