CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
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Project Number
J0614

Project Title
Does the Temperature of an Acid Affect the Ending pH and Temperature of the Mixture When the Acid Is Mixed with a Base?

Abstract

Objectives/Goals
My objective was to find out how different temperatures of an acid affect the pH and temperature of a solution when the acid is mixed with a base having a constant temperature.

Methods/Materials
I did a series of 6 experiments of 8 trials each, mixing 3 different acids into a base. The 3 acids, lemon juice, vinegar and muriatic acid, were each heated or cooled to 8 different temperatures at 10 degrees Celsius apart before I mixed them with the base, sodium bicarbonate in water, which was a constant temperature. I measured the pH and temperature of each acid and the base. Then I used an ice water bath to cool or an evaporation dish burning rubbing alcohol to heat each beaker of acid to 8 different temperatures at 6 degrees C, 16 degrees C, 26 degrees C, 36 degrees C, 46 degrees C, 56 degrees C, 66 degrees C and 76 degrees C. I mixed 20 ml of each acid with the sodium bicarbonate solution which was 15 ml of water and 10 ml of sodium bicarbonate. The base was always at 14 degrees C. I then measured the pH and the temperature of the mixture. For the first 3 series, I used a non-temperature compensating pH meter and for the second 3 series I used a temperature-compensating pH meter. I repeated the 6 series for a total of 12 series and 96 trials in all.

Results
My results show that as the temperature of the acid went up, the pH of the resulting mixture went up as well. This means that more hydrogen ions were freed up when the mixture was heated, even though adding the acid to the base tended to neutralize the pH of both the acid and the base. It also appeared that the temperature-compensating meter showed the correct pH and the non-temperature compensating meter was not as accurate.

Conclusions/Discussion
I am trying to figure out how to make a perpetual battery, and changing the temperatures of acids, bases and a mixture of them could be used to make a stronger battery, since the strength of an acid is measured by the number of free hydrogen ions, and heating and cooling acids, bases and mixtures of them can cause there to be more or less free hydrogen ions, and the hydrogen ions in battery acids is what causes the current to flow, at least in a car battery. As a result, I now know that temperature could be effective in controlling the release of hydrogen ions and as a result in building a better battery. Next, I intend to test how this could be used best in a battery.

Summary Statement
When I mix heated or cooled acids with a base which is at a constant temperature, cooling and heating the acids results in changes in the pH and temperature of the mixture.

Help Received
My mother edited my report; she also acted as the Designated Supervisor (required by County Science Fair rules for acids research); I had a Qualified Scientist (required by County Science Fair rules for acids research) who helped explain the chemistry of acids and bases; and my father helped me with the graphs.