Joshua Wise
2004-10-20

Title: Chemical Changes and Equations

Background:

Recently, our class has been learning about chemical equations, the *de facto* standard for describing the reactants and products of a chemical change. A chemical equation shows the relative number of reactants that combine to form a relative number of products. It can show such patterns as combustion (Hydrocarbon + O_2 -> CO_2 + H_2O), double displacement (A1C1 + A2C2 -> A1C2 + A2C1), and decomposition (Compound -> Element + Element).

Chemical equations must always satisfy two requirements, namely: 1) Chemical equations must always have valid formulas, and 2) Chemical equations must always be balanced. This means that ions must really have correct formulas (i.e., no $Fe_{18million}O_3$), and that matter must be conserved - i.e., the count of all, for example, oxygen in the reactants must equal the count of oxygen in the products. Chemical equations can have any number of reactants and products, although they certainly get difficult to work with if they have too many!

Purpose:

In this lab, we will practice with writing and balancing chemical equations. We will also experience first-hand what the signs of a chemical reaction of a certain type are. We will also practice identifying products of reactions. We will show that a reaction may produce multiple products, and that the product of one reaction may be used as a reactant in another reaction.

The four reaction types that we will be studying in this lab are synthesis, decomposition, single displacement, and double displacement.

Procedure:

To replicate this lab, one needs the following materials:

- One 13cm strip of magnesium
- One crucible
- One evaporating dish
- One clay triangle
- One ring stand and ring
- One Bunsen burner
- One striker
- A source of methane
- Forceps
- A source of water
- Two large test tubes, stopper, and right angle glass tube
- A source of calcium carbonate ($CaCO_3$)
- A source of limewater ($CaOH_{2(aq)}$)
- A source of hydrochloric acid ($HCl_{(aq)}$)
- A piece of zinc

- A small test tube
- A small splint and match
- A supply of strontium nitrate
- A supply of nickel sulfate

One can replicate the lab through the following steps:

1. **Synthesis**

1.1. Clean out the crucible.
1.2. Roll the magnesium into a loose ball and place it in the crucible.
1.3. Place the crucible in the triangle, and place the triangle on the ring.
1.4. Set up the Bunsen burner under the ring, connected to the source of methane.
1.5. Light the burner with the striker. Adjust the oxygen flow, as well as the gas flow, to full. The bottom of the crucible should be just at the top of the blue cone.
1.6. Monitor the magnesium carefully. It will momentarily become extremely hot and extremely bright. When this happens, turn off the gas for the burner. **Do not look directly at the magnesium for more than a few seconds. It is burning extremely brightly, and may damage vision.**
1.7. Ooh and aah at the spectacle, and wait for the magnesium to extinguish. Allow the crucible to cool, and remove it from the ring.
1.8. Scrape the remaining contents of the crucible into the evaporating dish.
1.9. Add some tap water to the evaporating dish.
1.10. Carefully smell the dish to see if there is any ammonia. **Ammonia smells bad. It's probably a bad idea to inhale a lot of it. Do not stick your nose in the dish. Instead waft some of the scent using your hand.**
1.11. Discard all contents into a basic waste container, and clean up.

2. **Decomposition**
3. Obtain three or four chips of calcium carbonate (CaCO3) and place them in a test tube. Fit the stopper in the top.
4. Pour some of the limewater (Ca(OH)2) into another test tube. **Ca(OH)2 is very caustic. Do not let it touch your skin.**
5. Add some hydrochloric acid into the test tube containing the calcium carbonate, and quickly put the stopper back on. Insert the right-angle b end, and point the other side of the tube so that it causes the limewater to bubble. **HCl is a strong acid. Do not let it touch your skin.**
6. Look for a precipitate in the limewater.
7. Empty the CuCO3 + HCl mix into the acid waste container, and the CuCO3 into the basic waste. Clean up.
8. **Single Displacement**
9. Clean the test tubes out.
10. Place the small piece of zinc into a test tube. Add hydrochloric acid. **HCl is a strong acid. Do not let it touch your skin.**
11. Quickly put the stopper/glass tube assembly onto the end of the test tube. The tube should be pointing straight up. Place another regular-sized test tube on the end of the glass tube.
12. Wait for about 30 seconds. Keeping the tube over the end of the glass tube inverted, move it away from the glass tube using forceps.
13. Light the wooden splint using the match. Bring the now-burning splint towards the bottom of the test tube containing the gas. Listen for a "pop", "bang", or "bark".
14. Repeat until urge to blow hydrogen up is satisfied.

15. Remove the rubber stopper and empty the acid-containing tube into the 'acidic waste' container.
16. Clean up.
17. Go outside once fire alarm sounds. Make sure that Bunsen burners are turned **off**!
18. **Double displacement**
19. Place some strontium nitrate ($Sr(NO_3)_2$) into a small test tube.
20. Place some nickel sulfate ($NiSO_4$) into same test tube.
21. Marvel at cool precipitate.
22. Dump precipitate into trash can, clean up.

Data/Observations:

The magnesium did not ignite on the first attempt. On the second attempt, the magnesium emitted a bright white light and heated dramatically. The Bunsen burner also gave a nice blue cone. Other lab groups reported having a red-orange flame shoot out of the front of the burner, although we did not experience this. We did detect the unmistakable aroma of ammonia gas (NH4).

Our group did not get around to attempting the decomposition, however other groups got the expected results (i.e., a gas from the calcium carbonate + acid mixture, and a precipitate in the limewater.)

The gas gicen off by the zinc + hydrochloric acid reaction produced a small "bark!" when ignited.

The strontium nitrate + nickel sulfate solution produced an emerald green "goo".

Data analysis:

The author could conclude by the data observed that the following reactions occurred:
While lighting the Bunsen burner: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ (Combustion, exothermic)
While burning the magnesium: $3Mg + N_2 \rightarrow Mg_3N_2$ (Synthesis, exothermic)
While detecting ammonia: $MgN_2 + 3H_2O \rightarrow MgO + O_2 + 2NH_3$ (Decomposition, endothermic - felt slightly cool)
While reacting calcium carbonate: CaCO3 + 2HCl -> H2CO3 + CaCl2 (Synthesis, endothermic - felt slightly cool)
Also while reacting calcium carbonate: H2CO3 -> H2O + CO2 (Decomposition, endothermic - felt slightly cool)
While reacting limewater: Ca(OH)2 + CO2 -> (?)
While reacting zinc and hydrochloric acid: Zn + 2HCl -> ZnCl2 + H2 (Double displacement, exothermic - felt slightly warm)
While exploding hydrogen: 2H2 + O2 -> 2H2O (Combustion, exothermic - went bang!)
While reacting the double displacement: Sr(NO3)2 + NiSO4 -> SrSO4 + Ni(NO3)2 (Double displacement, exothermic - felt slightly warm)
The author determined that the changes observed were chemical because the substances changed their behaviors, as opposed to solely changing phase.
The author was able to detect the presence of ammonia gas. This suggests that the magnesium did not only combine with oxygen - instead, it combined with nitrogen.
It is possible that hydrogen was not the gas produced, because other gases, such as methane, have a tendency to react in the same manner.

A reversible reaction is when the products can be turned back into the reactants.

Conclusions and error analysis:

To sum up this experiment, the author completed the goal - practicing writing chemical formulas and equations. The author, ironically enough, got more practice doing so while writing this lab report as opposed to performing the lab, but such is life. This lab had a lot of room for error. The crucibles were not necessarily clean. However, magnesium is one of the only substances that react as we noticed, so the author believes that any error was not quantifiable, and certainly did not adversely affect the results seen. The other source of error that the author believes may have contributed to this lab's error margin may have been that the authors were forced to stop in the middle for a fire alarm, possibly caused by the lab.