

3.2.6: Lecture Demonstrations

There are many demonstrations that purport to exemplify mass relationships and stoichiometry, but they deal with solutions or gases.

When reactions are demonstrated with solutions^[1], students usually must (1) trust that a reported molarity is correct, and (2) deal with a layer of abstraction (reactant masses must be calculated from volumes, using the reported concentrations and molar masses. If gases are used (with a eudiometer, etc.)^[2], the layer of abstraction exists through the ideal gas law.

In reactions between weighable reactants, (1) the product must not be lost as a smoke, etc., and (2) one reactant must be easily removed, so that the mass of a reactant can be determined from the mass of product less the mass of the other, initially weighed reactant. There are several possibilities, but none gives truly quantitative data, so they are best carried out (possibly with openly "idealized" data) to illustrate how a more carefully controlled experiment could yield more accurate results.

1. Al (or Zn , Mn) + I_2 Powdered aluminum and powdered iodine are mixed together and then one or two drops of water are added to the mixture. Shortly after the water is added, a vigorous reaction occurs. There is flame and lots of iodine vapor given off. Some of the iodine vapor can be seen to be reacting to form some other substance because the color is no longer violet but kind of a reddish brown. This vigorous reaction shows that aluminum metal is a fairly strong reducing agent and iodine solid is a fairly strong oxidizing agent.^[3]
2. $\text{Al} + \text{Br}_2$ (here some AlBr_3 may be lost along with vaporizing Br_2) Must be done in a hood.^[4]
3. Fe (or Zn) + S (here the excess sulfur burns in air, without much loss of ZnS). Must be done in a hood.^[5] Metal powder and sulfur are mixed. A heated metal rod causes the mixture to react vigorously.

^{[6][7]} FeS is nonstoichiometric, but close to 1:1^[8].

1. $\text{Mg} + \text{S}$: In a mortar and pestle, grind together precisely weighed portions of ~0.5 g of powdered magnesium and about ~0.7 g powdered sulfur (Sulfur is flammable; it may be irritating to the eyes and to the respiratory system if inhaled as a dust. Pour the powder on a fireproof weighed ceramic plate, and ignite with a propane torch or butane torch lighter. Combustions forms a toxic and corrosive gas. Weigh the product.
2. $\text{P} + \text{Br}_2$ ($\text{PBr}_4^+ \text{Br}^-$ decomposes to PBr_3 which may escape as smoke or vapor). Care! the reaction is quite violent with either red or white phosphorus. Must be done in a hood.^{[9][10][11]}
3. pyrophoric iron in air. Need not be done in a hood. Pyrophoric iron is not pure Fe , and the reaction isn't simply $\text{Fe} + 3/2 \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3$. But the reaction of pyrophoric iron with air is spectacular, and if a known mass of pyrophoric iron is spilled through air and collected, a calculated value for the mass of the product can be used, with appropriate caviates, to illustrate stoichiometric concepts.

References

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